# Social Psychology of Visual Perception

Edited by Emily Balcetis
and G. Daniel Lassiter

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# About the Editors

**Emily Balcetis** is an Assistant Professor of Psychology at New York University. She received her Ph.D. in 2006 from Cornell University in Social and Personality Psychology. Her research provides a comprehensive examination of the pervasiveness of motivational biases in visual perception and decision-making, exploring both conscious and unconconscious effects using a balance between traditional and novel techniques, paradigms, and approaches.

Her research has been recognized by the Society for Experimental and Social Psychology 2007 dissertation of the year award, a highly selective and esteemed honor, and the Cornell Clark Teaching Award in part for her involvement of undergraduate students in the research process. In addition, her research has been appreciated and supported by the popular media as it has received attention in *Science*, *ScienCentral*, *APS Observer*, *Skeptical Inquirer*, *National Public Radio*, *Time* magazine, and many major news outlets. In addition, she has received funding from organizations to continue her research from a variety of funding agencies.

**G. Daniel Lassiter** is Professor of Psychology at Ohio University and a fellow of the Association for Psychological Science. He received his Ph.D. in 1984 from the University of Virginia and held positions at Northwestern University and the University of Florida before arriving at Ohio University in 1987. For more than 25 years, he has conducted research on perceptual mechanisms in social judgment and decision-making. His systematic investigations of the way observers perceptually organize continuous streams of behavior into discrete, discriminable, describable actions has provided fundamental insights about the nature and comprehension of social action and interaction.

A related, but more applied, program of scholarship aimed at examining the effect of presentation format on how mock jurors evaluate confession evidence has influenced national policy in New Zealand and earned Dr. Lassiter the 2010 Award for Distinguished Contributions to Research in Public Policy from the American Psychological Association. Both lines of Dr. Lassiter's research have been supported by funds from the National Science Foundation and together have resulted in more than 75 scientific publications. He is the editor of *Interrogations, Confessions, and Entrapment* (2004); co-editor of *Police Interrogations and False Confessions: Current Research, Practice, and Policy Recommendations* (in press); and is presently consulting editor for the journals *Law and Human Behavior, Legal and Criminological Psychology*, and the *Open Access Journal of Forensic Psychology*.

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# Foreword: A New Look at the "New Look"

## JEROME BRUNER

This book is dedicated to reexamining the nature and determinants of perception – classic issues. For how best to conceive of perception is still not a settled matter, despite its long history. What we do know for sure, though, is that how we conceive of perception will inevitably affect how we go about investigating its nature.

I have been asked to provide some introductory remarks, principally by way of historical background, though such is scarcely necessary, for the authors of individual chapters are plainly mindful of such background. I thought, rather, that I might concentrate on what launched perceptual research into what came to be called the "New Look" – nearly a half-century ago.

Perhaps the dominant approach to the study of perceiving before then might best be called "psychophysical parallelism." Its main effort was to establish parallels between the subjective, experiential phenomena of perceiving and the processes (in the brain, or wherever) that produce those phenomena. Perceptual *Gestalten*, for example, should require physical Gestalten at the input side, presumably in the brain. Perception in these terms was the conversion of physical input into somehow isomorphic subjectivity. So, to take an example, a just noticeable difference in the subjective appearance of any physical input (a "jnd," so-called), should be produced by a *constant* fraction of change in physical input – the so-called Weber Fraction (Boring, 1950). A psychic *jnd*, in a word, is produced by a constant fraction of change in physical input – an elegant psychophysical parallel! Or indeed, as Koehler argued in his rather obscure William James Lectures (1938), a subjective Gestalt should somehow "represent" a physical Gestalt in the brain and not just a scattering of sensory activity.

But, alas, neither Weber's Fraction nor Gestalt isomorphism stood up to close inspection. Subjective experience, alas, does not "parallel" the neural pattern produced by physical input in any usefully predictable way. Nor did any of those "classic" parallelist approaches come near to dealing with the real-life, dynamic qualities of perception – its patent "quest for meaning" with its striking selectivity.

So alternative theoretical models were sought that dealt with the motivated "leap beyond the information given" that characterizes perception. What rules guided this leap? Associationism was one answer proposed. In its account, subjective experience reflects the history of past inputs to the sensory system and the links in those inputs in time, space, quality, and effect. That is to say, subjective experience achieves its order by virtue of stimulus inputs having definable relations to each other in the past. The world of experience, on this account, is organized principally to reflect how the input elements of the physical world had impinged on the sensory world of the beholder in the past and with what effect. The relationship between present and past inputs became the principal determinant of perceptual organization (and of mental life generally). Present subjective experience, in a word, is a reflection of one's history of past exposure to the world, how one had experienced it before.

The principal weakness (indeed, the fatal weakness) of associationism is that its principal explanatory approach is so loosely conceived (and so poorly defined) as to be virtually useless in any save a metaphoric sense. And even worse, it leaves so little room for the innovative side of mental life.

I want to consider now a radically different approach to "real-life" perception. Let me call it "activist phenomenology." For such a phenomenology, mental or subjective experience is conceived of as organized in support of our "ordinary," intention-driven activity. It asks how our intentions and our goal-directed actions shape how we perceive the world. Its approach, as it were, is more top-down than bottom-up, in contrast with association theories. Intention, expectancy, one's history of striving now come to play a central role in the selectivity of perception. Sensory input matters, of course, but its representation in experience is controlled by higher order processes. Concepts like "set," priming, and *Einstellung* now come to play a more central role in the organization of perception.

I'm sure it was the tradition of activist phenomenology that produced what, nearly a half-century ago, was dubbed the "New Look" in perception research. In its view, perceptual experience was not governed exclusively either by bottom-up *autochthonous* factors, such as Gestalt rules of figure-ground formation, or by rules of association. One also had to take into account such top-down *behavioral* factors as need, value, anticipation, even certain general factors: anxiety, frustration, and the like. One's cultural shaping, consequently, would also affect how one perceived the world. For, after all, our culture also shaped our beliefs, needs, and anticipations. So activist perceptual theory also seeks to take account of a perceiver's past history within a particular culture, for that too matters in shaping expectancies and the like.

But note that cultures do *not* affect all their members in identical ways, so one must be mindful not only of intercultural but of intracultural differences. Bare comparisons of one culture with another do not suffice.

So let me offer some examples to make all this clearer. I shall lean heavily upon the research of our group at Harvard in those early days of the New Look – particularly from the late 1940s to the 1960s. And perhaps it's best to start with some rather obvious findings.

Take, for example, the amount of exposure time required for recognizing printed words that vary in their frequency of appearance in standard English text. The procedure was straightforward enough. Each word is presented successively at increasing exposure times in a tachistiscope, a gadget for presenting visual displays at varyingly brief intervals ranging from thousandths to hundredths of a second. As for any word's frequency of occurrence in standard English text, fortunately we knew a lot about it thanks to the well known Thorndike-Lorge frequency counts of ordinary English prose texts.

It was soon evident that the more frequently a word appears in ordinary print, the shorter the exposure required for it to be recognized when presented tachistiscopically. For some reason (still not clear to me!) this finding was taken to be obvious or self-evident – attributable to "habit" or some such seemingly simple process. But to our Harvard group at that time, this "frequency effect" suggested that there must be some sort of ordering of hypotheses about what to expect when exposed to the world of words.

Those early findings, indeed, led us to propose what later came to be called the "hypothesis theory of perception." That is to say, one's expectations about likelihood of occurrence of a stimulus affected how much input was necessary to recognize it: the stronger the expectation, the less extended the input needed for its recognition.

And indeed, further work suggested that this rule extended beyond sheer word frequency. It even held for the orthographic structure of language, for spelling or letter sequence. Indeed, George Miller, Leo Postman, and I devised an experiment (1954) in which we presented subjects with letter strings that were varying approximations to English spelling. Zero-order approximations were constructed by choosing each successive letter at random from a standard text and stringing them into eight-letter sequences. First-order approximations were constructed by choosing an initial letter at random, then selecting the letter following it in standard text, then choosing the letter following that one in standard text. A second-order approximation was constructed by choosing the letter in standard text that followed a preceding *pair* of letters selected in that way. By the time one got to fourth-order approximations to English – where each letter was chosen by dint of its following the preceding four letters in a standard text – one got very close to English might-have-beens: almost English nonsense strings like VERNALIT, MOSSIANT, POKERSON.

Needless to say, the higher the order of approximation of a word to English, the less tachistiscopic exposure was needed to recognize it. Indeed, perceptual readiness seemed tuned not only to the likelihood of occurrence of *words* but also to their orthography – micro as well as macro.

But that's only part of the story, the non-controversial part. Now let me go on to some more controversial studies from that early New Look period. The first, again, concerns the time required to recognize tachistiscopically presented words. This time we, Leo Postman and I (1947), presented our subjects with mid-frequency English words, including among them some that were rather obscene or, at least, "crude" for an experiment in a university lab – among them *hymen, penis, whore*, and the like.

The results surprised us. Obscene words were recognized by some subjects *more* rapidly and by other subjects more slowly than everyday ones. To make sense of this anomalous finding, we invoked a distinction between perceptual "vigilance" and perceptual "defense." Vigilance is elevated sensitivity to irregularities in the world around us, to the unexpected or tabooed: hypersensitivity to violations of the ordinary. Defense, on the other hand, is avoidance of the unexpected or of the tabooed, marked either by a tendency to conventionalize or to avoid the unexpected or the offensive. The findings, indeed, suggested that there might even be some psychoanalytic mechanisms operative in perception – not a welcome idea among some of our experimentalist colleagues.

But indeed, other tachistiscopic studies then in progress or soon to follow seemed to confirm this suspicion. Work then in progress on the perception of incongruities (Bruner & Postman, 1949) provided some interesting hints. Let me say a word about this work. We created perceptual incongruities by fashioning stimuli that, by any standards, so violated ordinary expectancies (or probabilities) as literally to seem incongruous. We could compare across subjects the difference in recognition time between ordinary pictures and incongruous ones as well as the difference in approach. In one such pair, to provide some detail, the normal version was a fairly close-up photograph of an Olympic athlete throwing the discus, while the incongruous version had the discus-thrower holding a bass viola tucked under his free arm. The congruous–incongruous pairs, I must confess, were weird fun to design – a bit like making up absurd jokes! I should also mention, though it is surely obvious, that individual subjects in the experiment were presented *either* a congruous or an incongruous picture, never both.

Needless to say, the incongruous one in each pair took far longer to identify correctly. But interestingly, its recognition was often accompanied by amused but astonished surprise – what we came jokingly to call the "Jesus Christ!" reaction, as in "Jesus Christ, that discus thrower's holding on to a cello with his free arm!" And just as an aside, there were some subjects (they were virtually all Harvard undergraduates, by the way) who, virtually from the initial highest speed presentation of incongruous pictures, would make remarks like "Hey, there's something crazy about that picture, but I can't make out what it is." Were they the hypervigilant ones?

Perception, indeed, is psychological. It serves more needs than simply representing the world out there. And yet, and yet . . .! It *also* serves that representational function. It is multi-purpose. It is surely *not* a simple or unilinear process!

Let me turn finally to the perceptual management of sensory attributes such as apparent size, color, shape. I say "management" rather than "representation" for good reason. For perception serves not only to *represent* but to highlight, to dim down, to exaggerate features of the world in useful and sometimes in panic-stricken ways. Again, I want to go back to an early experiment of the "New Look" days, one that I did jointly with a Radcliffe tutee of mine, Cecile Goodman, who submitted it for her honors thesis (Bruner & Goodman, 1947). It had to do with what we called in those days the "accentuation" of significant perceptual features – in this case, the apparent size of coins of different value. The idea came to me while reading Egon Brunswik (1934) on perceptual tuning, his argument being that perception highlighted life-critical aspects of particular sensory inputs. I also happened to be immersed in Faulkner novels at the time, and in one of them some kid has just been given a quarter for helping out with some chores. He clutches the coin in his pocket and feels it grow in his hand. It reminded me, I must confess, of an odd thought I'd had as a young teenager: that half-dollar coins didn't seem as large as they did when I was a little kid – or perhaps *weren't* as large.

So we did an experiment, Cecile and I, on the apparent size of coins (Bruner & Goodman, 1947). A subject was to reproduce the size of a coin held in his hand by adjusting an elegant but simple apparatus on whose front end a circle of light could be varied in size by turning a knob. Our subjects, we decided, should be kids, well-off ones (mostly children of Harvard faculty) and poor ones from a run-down section of Cambridge on the "other side" of Central Square.

And sure enough, the more valuable the coin, the more was its size overestimated – except for the dime, whose size is almost always underestimated, at least by Americans. And to our surprise and delight, this value–size effect was the more striking among the poor kids than the well-off ones.

But why did this little experiment so catch the public imagination? It even made the daily papers – I can't recall now whether in the *New York Times* or the *Boston Globe*. I confess embarrassment not having mentioned William Faulkner in that Bruner–Goodman article, by the way, but citing novelists in the pages of professional psychology journals was just not done in those days.

Anyway, there were lots of attempts around the country to replicate those findings – or better, really, to disprove them. Some succeeded, some didn't. For me too! I found you could reproduce those findings, provided you didn't create too stern and "serious" an atmosphere in the experimental situation. Create a vigilance-evoking emphasis on "size judgment" and the effect disappears. Indeed, judgments of sensory attributes are notoriously situation-dependent and bedevilled by set – back to those famous *Einstellung* effects of our nineteenth-century forebears.

That Bruner–Goodman experiment certainly strengthened my convictions about the broader instrumental nature of perception. And let it be said as well that it reinforced my conviction that one does well to read literary geniuses like William Faulkner for hints as well as for enjoyment!

Let me close now – though I have not said a single word about the chapters that follow in this book. Nor can I do so, for circumstances and deadlines have interfered irreversibly and I have only been able to scan them. Yet they plainly represent for me what is a next phase in the seemingly endless history of perception. My fellow authors simply take it for granted that perception serves a core function in our adjustment to our culture, to our needs, and to the demands of our inevitably conflicted lives. And the task they set themselves is to explore how this all works.

My aim in this foreword has been to set the stage, the *historical* stage. And that is just as well, for I no longer work on perception in the usual sense of that word. Nonetheless, perception is, as it were, inescapable. In more recent years, for example, I have been principally involved in trying to understand how the human condition affects and is affected by our system of law. My teaching at the New York

University School of Law centers around this theme. Believe me when I say that perception is central to any system of law, and not simply because it is so crucial to what we call the rules of evidence. In the deepest sense, our view of perception affects our conception of the real and how we come to our convictions about what is to be taken as reality. My views on these matters are developed at some length in two fairly recent books – Amsterdam and Bruner's *Minding the Law* (2000) and my own *Making Stories: Law, Literature, Life* (2002).

I welcome the present book. Indeed, I look forward to reading it more closely now that the pressure of deadlines is past. And I shall get my law students to read it as well.

I am deeply honored to have had a part in it.

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# Introduction

## EMILY BALCETIS and G. DANIEL LASSITER

Before and since Diderot and D'Alembert sat down over coffee during the eighteenth-century Enlightenment in Paris' Café Procope to create the *Encyclopédie*, scholars of all types have debated how people achieve "true" knowledge. A recurring question for philosophers and scientists alike is how people can and do gain a complete understanding of the world and all its components. That is, whether done through passionate exchanges in erudite salons, empirical observations in public gathering spaces, trolling Google's internet webpages, or the like, the objective was and is to discover how people achieve an accurate, reliable, and fixed knowledge of the outside world. Inherent in such musings is the notion there is an objective reality or concrete, singular way in which to comprehend the world. And with enough effort, people can come to know it.

We disagree. We, the contributors to this volume, put forth the premise that people's understanding of the world is in fact highly, if not exclusively, subjective. We question whether people do achieve a true, accurate, and veridical understanding of the world. Instead, we suggest that even at one of the most basic, fundamental levels people do not maintain a purely objective sense of reality. In particular, the fundamental way in which people literally see – that is, visually perceive – their surroundings can be characterized as "distorted." Although people think they see their outside world as it really is with a full understanding of all it has to offer, the main implication of this volume is instead that what people think they see is in fact something of a misrepresentation of reality.

The primary goal of this volume is to present an overview of the diverse ways in which social, personality, cognitive, and neuroscience psychologists are currently exploring the science of visual perception. While many would tacitly assume that perceptions are veridical representations of reality, research conducted by the contributors to this volume contests this supposition. The contributors discuss their recent contributions to the debate centering on the veridicality of visual experiences. These contributors were selected for their diverse approaches to this emerging discipline that combines the interests of social, personality, and cognitive psychology among other disciplines and interests. While the approaches may be disparate, all contributors to this volume offer evidence that visual perception is malleable.

Throughout this volume, the contributors argue that perceptual experiences are variable. While perceptual experiences are driven by the actual shapes, textures, colors, and locations of the parts of the objects in the environment, they too are influenced by other higher-order factors external to these objects. This volume focuses on those specific factors that are inherent in the perceiver himself or herself. That is to say, perceptual experiences are dependent on the interaction between the properties of the visual information that perceivers' eyes acquire and the psychological and physical states perceivers simultaneously experience. Throughout the volume, the contributors support the assertion that these social variables impinge on visual processing quickly and outside of conscious awareness. Perceivers simply do not realize that they are seeing a world that is to a large extent unique to them.

This volume has as its primary goals to (1) document the many social psychological factors that shape perceptual experience, (2) provide evidence for the mechanisms by which such factors exert their influence, and (3) provide theoretical reasons and empirical evidence for the rationale behind such a visual system. It was also our intention that the information contained in this volume would be presented in a manner that made it accessible not only to academics in psychology and related behavioral sciences, but to undergraduate and graduate students in these disciplines, to practicing clinical psychologists, to the media, and to intellectually curious others who happen upon this collection.

While this volume is divided into three sections, all share similar objectives. Common among all sections and chapters is the guiding theory that perceptual experiences are shaped by both chronic and temporary states of perceivers in addition to the situation in which perceivers find themselves. It is the purpose of Section I, and a reoccurring theme through Sections II and III, to suggest a range of social psychological influences that shape visual perception. Contributors investigate factors that influence visual processing that were themselves once considered exclusive to the domain of social psychology. For instance, contributors discuss the role that stable and consistent membership in groups, including ones formed through racial and cultural divides, plays in shaping perception (Chapters 1, 2, 3, 11). Similarly, contributors discuss the role of social context such as physical attractiveness and cues gleaned from observing others' behaviors in perception (Chapter 8). While enduring qualities both internal and external to the perceiver affect perception, contributors also suggest that temporary experiences similarly shape visual perception. For instance, active wishes and social goals shape perception (Chapter 4). Likewise, states of the physical body (Chapters 5, 9), affective states (Chapter 6), and emotions (Chapter 12) can bias the ways in which the visual system operates.

In addition to documenting a host of social influences on visual perception, the contributors provide convergent evidence that higher-order, top-down influences constrain visual perception at multiple stages of visual processing. For instance, social influences can affect perceptual experiences by biasing the direction of visual attention (Chapters 2, 3, 4, 6, 7), ambiguity resolution (Chapters 1, 4, 5, 8, 11, 12, 13), and the manner in which the incoming information stream is parsed (Chapters 10, 13), among other tasks the visual system undertakes to form a perceptual experience.

The purpose of Section II is to investigate the neural mechanisms in the brain underlying such effects on visual perception. Contributors discuss the neural regions, pathways, and interacting systems responsible for producing biased perceptual experiences. For instance, contributors discuss the neural systems responsible for integrating visual information and internal affective states (Chapter 6) in addition to states, movements, and locations of the physical body (Chapter 8) to guide perceptual experience. In addition, contributors suggest that the amygdala is sensitive to socially relevant information, such as emotional cues, and subsequently determines the manner in which visual information is attended to, registered, and processed (Chapter 7).

The purpose of Section III is to discuss evolutionary, ecological, and developmental bases for such a visual system. Contributors to Section III take a variety of approaches to their theorizing. For instance, contributors (Chapter 12) discuss inferential approaches to perception whereby assumptions, biases, and knowledge inherent to the observer are combined with the geometry of the world [upon which] the visual system picks up. Reflecting the development of the field's theorizing, contributors (Chapters 11, 12), too, consider J.J. Gibson's ecological approach to visual perception, redefining visual perception as a function of the interactive relationship between the perceiver, the object of perception, and the manner in which a perceiver can behave with and react to that object. In addition, contributors (Chapters 10, 13) draw on the ecological approach to call attention to directly perceptible information in the evolved structural qualities of objects in the environment that suggest ways in which perceivers might behave in response to those objects.

Together, this volume proffers comprehensive and compelling evidence that the world people think they see is not necessarily an accurate reflection of reality. The world people know, the one they act in and on which their actions are based, is the one they take in through their senses. However, perceptions of the world are subject to influence from a host of characters much greater and much more broad-reaching than the input that perceivers' eyes receive. As a result, perceptual systems are penetrable. These chapters deliver a diversity and wealth of evidence that the visual system is indeed subject to influence by complex, social, psychological constraints once considered exclusive influences on complex behavior. In conclusion, to determine how people come to know their outside world – how they form an understanding of reality – it is important to investigate the many social psychological factors that shape visual perception. This volume is offered as a guide through this examination and as an impetus for continued scientific analysis of the role of social psychology in influencing what we see and how we come to see it. So, let the exploration begin.

# Section I

# Motivation and the Social Psychology of Visual Perception

# 1

# Ambiguity and Social Perception

KRISTIN PAUKER, NICHOLAS O. RULE,
and NALINI AMBADY

> Each of us literally chooses, by his way of attending to things, what sort of universe he shall appear to himself to inhabit. (James, 1890/1983, p. 416)

People routinely make judgments based on social categories (i.e., categories that place an individual within a larger social group such as sex, race, sexual orientation, religion, occupation), and are quite adept at extracting others' social category memberships (Bruce & Young, 1998; Cloutier, Mason, & Macrae, 2005; Macrae, Quinn, Mason, & Quadflieg, 2005). However, not all social categories are easily discernible. Some social categories are concealed, whereas other visually identifiable social categories may be obscured by conflicting cues or contexts. Whether making a judgment based on a concealed identity (e.g., sexual orientation) or a social identity with a mixture of cues (e.g., multiracial), both judgments involve construing a category based on ambiguous perceptual cues. Do the perceptual and cognitive processes underlying social categorization function for ambiguous social targets just as they do for perceptually obvious targets? We propose that although perceivers are surprisingly accurate at construing the identity of these ambiguous targets despite their "degraded" informational input, such construals are often constrained by additional cues, such as the context of the surrounding environment or the perceiver's motivation. In particular, perception of facial cues that mark these social categories may be particularly susceptible to top-down influences as identity cues become increasingly ambiguous.

The initial step of determining whether someone is a "friend or foe" is often taken for granted in most social psychological research. With perceptually obvious categories, facial category cues are strongly associated with *one* category construal; however, with ambiguous social categories, category cues may be associated with multiple categories, allowing for contextual input and motivational factors to exert their influence in resolving this ambiguity. Indeed, this crucial step of category construal may set the stage with regard to whom we attend to or how we "see" an individual. We review evidence for motivational influences in perception, focusing on the malleability of face perception across several stages of visual perception.

Additionally, we discuss the implications that such fluidity in perception has downstream, particularly with regard to face memory. Overall, we illustrate the malleable nature of social perception, where both higher-order social cognition (e.g., personal motivations, cultural associations, and contexts) and bottom-up perceptual operations collaborate in tandem to produce our routine sights and interpretations of the social world.

## ACCURACY IN CONSTRUING PERCEPTUALLY AMBIGUOUS SOCIAL CATEGORIES

Most person perception research, to date, has focused on groups whose perceptual boundaries are marked by obvious and explicit cues. Indeed, distinctions between individuals of different ages, races, and genders are typically so apparent that these categories are often considered to be special classes that humans are innately predisposed towards perceiving (e.g., Brewer, 1988). Among these “Big 3” categories, then, it is very difficult to discuss the capacity for accurate perception because discrimination of individuals into groups is so facile. Emerging work, however, has begun to demonstrate the perceptibility of individuals belonging to groups that are not as perceptually distinct. This examination of perceptually ambiguous groups allows for potential insight regarding the capacity and limits of our ability to perceive and construe others.

Early studies investigating the question of accuracy in perceiving group membership examined the perceptibility of Jewish from non-Jewish individuals (see Rice & Mullen, 2003 for review). This research showed that perceivers could distinguish Jewish from non-Jewish individuals with accuracy that was significantly greater than chance from photos (e.g., Allport & Kramer, 1946) and live observations (e.g., Lund & Berg, 1946). Both perceptual context and perceiver identity showed important effects: Carter (1948) found that Jewish individuals were discriminable from non-Jewish individuals when contrasted against either Northern Europeans (high perceptual distinction) or Mediterraneans (low perceptual distinction). Additionally, Scodel and Austrin (1957) found that Jewish perceivers were more accurate than non-Jewish perceivers. A central focus among this work was the impact of anti-Semitism, or prejudice against Jewish people, on individual perceivers’ accuracy and response bias in distinguishing Jewish from non-Jewish individuals. The data were mixed, however, with some studies showing a positive relationship between accuracy and anti-Semitism (e.g., Dorfman, Keeve, & Saslow, 1971) and others showing no relationship between accuracy and anti-Semitism (e.g., Quanty, Keats, & Harkins, 1975).

A more recently studied perceptually ambiguous group is sexual orientation. Ambady, Hallahan, and Conner (1999) demonstrated that dynamic nonverbal cues allow for above-chance accuracy in perceiving sexual orientation (see also Johnson, Gill, Reichman, & Tassinary, 2007). Recently, Rule and Ambady (2008) showed that static, facial cues also allow for accuracy in judging male sexual orientation and that exposures to faces as brief as 50 milliseconds are sufficient for making accurate categorizations. Moreover, longer exposures (as long as 10,000 milliseconds and including self-paced judgments, which averaged about 1,500 milliseconds) were no more accurate than the very brief, 50 millisecond exposures. Critically, subliminal presentations of the faces at 33 milliseconds did not allow for accurate perceptions, suggesting a supraliminal threshold for accurate judgments.

Investigation into the facial features that contribute to such judgments showed that targets' hair, eyes, and mouth independently provided information that was distinctive for male sexual orientation, and the accuracy of judgments based on faces without these features was at chance (Rule, Ambady, Adams, & Macrae, 2008). Interestingly, however, perceivers were able to estimate the accuracy of their judgments when deciding based on hairstyles but were unable to estimate the accuracy of their judgments when deciding based on the eyes or mouth. That is, participants' postdicted accuracy, or estimated accuracy about their prior judgment performance, significantly correlated with the actual accuracy of their judgments when judging hairstyles; however, participants' postdicted accuracy of their judgments was not significantly related to the actual accuracy of their judgments when judging either the eyes or mouth. These findings suggest two potential routes for feature-based person perception: one that occurs from explicit and obvious cues (such as hairstyle) and one that occurs from intuitive and nonobvious cues (such as information coded in the eyes and mouth). Moreover, participants' postdicted accuracy was also unrelated to their actual accuracy when judging targets' full faces, which necessarily included all three of these features. This may be because competing information from the obvious and nonobvious cues undermined participants' ability to infer their own accuracy. Indeed, Rule et al. (2008) reported that the correlation between actual and postdicted accuracy for judgments based on full faces was intermediate between that for the obvious (hairstyle) and nonobvious (eyes and mouth) features.

The finding of separate explicit versus intuitive processes for the extraction of person information demonstrates one benefit of studying perceptually ambiguous groups. Because of the obvious and redundant nature of features contributing to the perception of perceptually obvious groups such as race (e.g., Maddox, 2004) and gender (e.g., Brown & Perrett, 1993), the examination of parallel, simultaneous perceptual processes may be obfuscated by the high signal expressed from the perceptually obvious cues – particularly in cases where specific cues classically define group membership (e.g., the role of skin tone in the construction of racial boundaries). Thus, the subtlety of distinctive features among perceptually ambiguous groups, such as male sexual orientation, may allow for examinations of how it is that we arrive at accurate perceptions and categorizations of other individuals that might not otherwise be accessible from studying perceptual boundaries that are clear and obvious. That is, accuracy in the latter case is achieved so easily that the processes leading to these judgments are difficult to tease apart. Interrogating the processes that underlie the perception of perceptually ambiguous groups can therefore potentially allow for novel insights into the perceptual and cognitive processes that may be occurring for the categorization of all groups.

## MOTIVATIONAL INFLUENCES IN PERCEPTION

Although perceptually ambiguous social categories have been under-examined, the utility of examining perceptual ambiguity has indeed long been recognized. Since the advent of the New Look movement in psychology, scholars have argued that ambiguity in the field invites motivational influences on visual perception. In their classic study Bruner and Goodman (1947) contended that increases in stimulus ambiguity heighten the opportunity for motivation or other contextual factors to influence perception. They emphasize that we live in a world of "ambiguously organized sensory stimulation" and thus what we see is actually a compromise between what is physically there and what has been selected based on contextual input, such as situational cues from the environment, or perceiver inputs, such as expectations or motivation.

Between 1947 and today, a plethora of studies have examined how environmental input, expectations, or motivation impact the cognitive processing of ambiguous stimuli (Alloy & Tabachnik, 1984; Atkinson & Walker, 1956; Balcetis & Dunning, 2006; Changizi & Hall, 2001; Duncan, 1976; Eberhardt, Dasgupta, & Banaszynski, 2003; Fazio, Ledbetter, & Towles-Schwen, 2000; Fazio, Powell, & Herr, 1983; Higgins & Tykocinski, 1992; Jenkin, 1957; Lambert, Solomon, & Watson, 1949; Lim & Pessoa, 2008; Muise, Brun, & Porelle, 1997; Postman & Crutchfield, 1952; Strachman & Gable, 2006; Trope, 1986; Voss, Rothermund, & Brandtstädter, 2008; Wyer, 1974). A number of these studies specifically examined the impact of motivation on visual perception. For example, Balcetis and Dunning (2006) observed that an ambiguous figure (the figure 13) was more often perceived as "B" or "13" depending on which of these interpretations was associated with a positive outcome for the perceiver. People see one dominant color in ambiguous bicolored stimuli when that color is associated with financial gain versus financial loss (Voss et al., 2008) and greater transparency (a property associated with water) in ambiguous objects when they are thirsty opposed to when they are not (Changizi & Hall, 2001). Specifically, in these more recent studies, great care was taken to ensure that participants were not merely reporting the desired outcome, but rather that visual perception was modified based on participants' motivations to achieve a positive outcome, gain financially, or seek out water.

In addition to perceiver motivations, associations that linger in the environment can shape perception of ambiguous objects. In the United States, where Black people are frequently associated with crime, subliminal priming with Black faces facilitated the detection of crime-related objects in impoverished contexts (Eberhardt, Goff, Purdie, & Davies, 2004). Thus participants were faster to identify a degraded image of a gun when primed with Black faces versus White faces. Similarly, Goff, Eberhardt, Williams, and Jackson (2008) demonstrated that individuals who hold an association between Black people and apes were faster to accurately detect the presence of apes in line drawings that transitioned from indeterminable dots to clear images, but only after subliminal exposure to Black faces. Thus, motivation and environmental associations can affect the perception of non-human objects, but can such information affect the perception of faces?

## MOTIVATIONAL INFLUENCES IN FACE PERCEPTION

Given the importance of face perception in facilitating successful social interactions through perceiving cues of affiliation, group membership, emotion, and intention, we would expect that motivation and environmental associations should also shape face processing – tuning mechanisms to the most important interpretations for a particular perceiver or in a given environment. Indeed, the ecological theory of face perception (McArthur & Baron, 1983; Zebrowitz, 2006), emphasizes both the functional nature of face perception and the role that perceiver qualities and social context play in moderating processing. A central tenet of this theory revolves around how *social affordances* – opportunities to act or be acted upon conveyed through the face – depend on the perceivers' *attunements* towards the stimulus information that reveal these affordances.

The concept of attunements directly encompasses our view of how face perception is not just detection of a configuration of stimuli, but depends on a combination of what information exists, what information the person attends to, and what information is useful to that perceiver in that particular environment (see Lassiter & Geers, 2005 for a similar argument that perception operates this way more generally). For example, motivations can act as attunements in face perception. People high in affiliation motives selected areas in their visual field as more favorable if a face, as opposed to a non-human object, was flashed below recognition level in that particular spot (Atkinson & Walker, 1956). Thus, even though they could not see the faces, an affinity for people directed their attention and preference towards areas where faces had appeared.

Similarly, a number of studies have explored the role of perceiver attunements in resolving ambiguous emotions. The emotions we feel can influence how long we see emotions last on another person's face. Niedenthal, Halberstadt, Margolin, and Innes-Ker (2000) established that participants who watched a short movie of a person's face gradually transforming from one emotion (e.g., happiness) to another (e.g., sadness) perceived emotions congruent to what they were induced to feel as lasting longer. In other words, if a participant was induced with happiness, she perceived happiness to last longer in a face transforming from happiness to sadness. Thus, specific emotional states can enhance processing of specific emotions. Individual differences in vigilance to social cues can also exert a top-down influence on the perception of ambiguous emotions. Fraley, Niedenthal, Marks, Brumbaugh, and Vicary (2006) found that individual differences in attachment-related anxiety filtered people's perceptions of ambiguous emotions. Fraley and colleagues argued that according to adult attachment theory, individuals with high attachment-related anxiety should exhibit hypervigilance to cues relevant to interpreting and monitoring emotion in others. Indeed, individuals high in attachment-related anxiety saw emotion disappear faster in an emotional face changing to a neutral one and appear faster in a neutral face changing into an emotional one. Moreover, these highly anxious individuals were also less accurate at identifying which of the three emotions (anger, sadness, or happiness) the actor was experiencing once they stopped the movie displaying the emotion morph. Thus, highly anxious individuals expressed vigilance towards perceptual change in ambiguous emotions, but this came with a trade-off in accuracy.

Context associated with an ambiguous emotion can also influence how that emotion is resolved. In an fMRI study, Kim and colleagues (2004) paired surprised faces with either a negatively or positively valenced contextual sentence. Surprise is an emotion frequently confused with fear, and fear has been shown in a number of studies to elicit increased response in the amygdala (Morris et al., 1996; Phillips et al., 2001; Whalen et al., 1998, 2001). Although the amygdala may also be responsive to surprised faces (Kim, Somerville, Johnstone, Alexander, & Whalen, 2003), this response may largely depend on valence judgments associated with the face – whether the perceiver interprets the emotional signal as positive or negative. Indeed, participants displayed greater ventral amygdala activation when viewing surprised faces disambiguated by a negative context (e.g., "She just lost $500") compared to a positive context (e.g., "She just found $500"). These data highlight that even neural responses to a particular facial expression may depend on the information value of an expression in a given situation or context.

Behavioral studies have also demonstrated that contextual information changes the categorization of ambiguous emotions. Situational cues associated with an ambiguous emotion (e.g., one that was perceived as a combination of fear and happiness) directed how that emotion was resolved (Trope, 1986). Thus, the same face was more likely to be perceived as displaying fear when combined with the cue "watching a horror film" compared to when combined with the cue "watching a comedy show." In a more recent study, participants conditioned to associate aversive shock with fearful faces were especially likely to see "fearful" responses in emotionally ambiguous faces (Lim & Pessoa, 2008). By manipulating the affective significance of the face, via prior history, Lim and colleagues shifted perceivers' attunements to fear signals. Even exactly the same faces can acquire a different meaning, subsequently changing how perceivers view them. Of particular importance, both of these studies compared the effect of context on emotionally ambiguous versus nonambiguous faces. Stronger contextual effects occurred in the case of emotionally ambiguous faces. In fact, Trope (1986) specifically proposed that expectations should take on a pivotal role with increasing ambiguity of the stimulus, particularly if the context clearly favors one category.

## RESOLVING AMBIGUITY IN GROUP MEMBERSHIP

Clearly defined contexts have been shown to play a role in resolving a number of perceptually ambiguous social categories, including racial and gender identity. Racially ambiguous faces are processed more holistically when categorized as in-group members (Michel, Corneille, & Rossion, 2007), an effect thought to take place at perceptual face processing stages (see Goffaux & Rossion, 2006; Schiltz & Rossion, 2006). Racially ambiguous faces are also rated as having more "Black" features when paired with a stereotypically Black hairstyle and are subsequently processed less efficiently (MacLin & Malpass, 2001). From the perspective of the perceiver, multiracial individuals – who may flexibly identify with multiple component identities – show changes in face processing when the context favors one racial identification over another. Chiao, Heck, Nakayama, and Ambady (2006) found that priming racial identity in biracial (Black/White) participants influenced how they performed on a visual search task that involved finding a Black face in a sea of White faces or a White face in a sea of Black faces. If primed with their Black identity, biracial participants performed the task much like Black participants and vice versa if they were primed with their White identity. Participants exhibited flexibility in their identity, as well as a change in visual perception based on the top-down influence of identity orientation.

Even cross-sensory cues can modulate the resolution of ambiguous gender categories. Kovács and colleagues (2004) found that smelling gender-specific hormones can bias gender discrimination. Participants viewed faces morphing from female faces to male faces and had to determine when the face changed to a different gender. After exposure to androgen, participants required less masculine features to perceive a face as male. When exposed to estrogen, participants required more masculine features to perceive a face as male. This effect is thought to occur at the stage where gender cues are processed in the brain, supported by another study that demonstrated that the fusiform gyrus, where face processing takes place, is strongly activated by similar gender-specific hormone-like compounds (Savic, Berglund, Gulyás, & Roland, 2001).

Faces to which people are exposed in their environment may also constrain the perception of ambiguous social identities or emotional expressions such that attunements to specific categories may be adaptively molded to the landscape of the social environment. Thus, attention becomes attuned to detecting particular differences based on the person's prior history (Lassiter & Geers, 2005). Webster, Kaping, Mizokami, and Duhamel (2004) found that exposure to a particular social category can shift the boundary where a morphed face appears to transition from one category to another. For example, after adapting to multiple presentations of male faces, the category boundary shifts towards the male category. As a result, the previous boundary, where gender was originally perceived as completely ambiguous, now appears indubitably female. On the other hand, adaptation to female faces enacted a category boundary shift towards the female end of the continuum. Webster and colleagues demonstrated similar effects with racially ambiguous and emotionally ambiguous faces. These studies provide evidence that clear environmental contexts shape the perception of ambiguous categories; however, cues in the environment may also interact with each other.

## INTERACTION OF MULTIPLE CONTEXTUAL CUES

Ecological theory specifically purports that multiple types of cues may interact to determine the social affordance of a particular face. Thus, not only may perceivers rely on cues from the environment, but these cues may also interact with cues from a variety of outlets – other contextual cues, dynamic cues or identity cues in the face, perceivers' group membership, or perceivers' motivation. For example, Webster et al. (2004) found that biased gender discrimination, displayed after adaptation to faces of a particular social category, was moderated by the perceiver's identity. People shift their boundaries towards their *own* social identity – an attunement that may heighten sensitivity to how out-group faces differ from in-group faces. These boundary shifts happened within minutes in the lab, but shifts based on longer-term exposure can also adjust perceived category boundaries. Asian students who lived in the US for approximately one year shifted their category boundaries towards the category boundary of Caucasian students. Additionally, these shifts over time were correlated with the percentage of time they had spent in the US and their level of interaction with Caucasian individuals.

In addition to shifting category boundaries, perceiver identity and context may work in confluence to affect early perceptual processing. Differences in event-related potentials (ERPs), which measure early attention responses, suggest that this early perceptual processing of in-group and out-group faces may depend on both perceiver identity and context (Willadsen-Jensen & Ito, 2008). ERPs are quantified by the type of waveforms that are produced in response to a particular event or type of stimuli. Whereas Asian participants showed larger P200s – a type of waveform associated with attentional vigilance – to out-group White than to in-group Asian or ambiguous faces (Ito & Urland, 2003, 2005; Kubota & Ito, 2007; Willadsen-Jensen & Ito, 2006), context exerted an effect in another early component – the N200 – a waveform associated with depth of processing and perceptual expertise. Asian participants more deeply processed in-group Asian and racially ambiguous faces in the context of seeing numerous other Asian faces; however, in the context of numerous White faces, they more deeply processed out-group White and racially ambiguous faces. Responses to ambiguous faces differed from in-group and out-group faces in a later component (LPP), known to be sensitive to incongruities in context and responses, and also differed in explicit categorizations. Notably, during explicit categorizations, racially ambiguous faces were contrasted from the racial context in which they were presented – participants categorized racially ambiguous faces as Asian more frequently when in the context of primarily White faces compared to the context of primarily Asian faces. In light of the adaptation effects we just discussed, those racially ambiguous faces presented in a White context, for example, are likely to cause a shifting of the perceptual boundary towards a White anchor, resulting in the observed contrast effect to perceive the ambiguous face as more Asian.

Similar to perceivers' identities interacting with context to direct the perception of faces, other perceiver characteristics may interact with context cues to constrain processing.In a clever study, Eberhardt et al. (2003) tested how perceiver characteristics (e.g., participants' lay theories) interacted with context cues (e.g., racial category labels) to affect perception of racially ambiguous faces. Participants saw a racially ambiguous face presented alongside a racial label (Black or White). When asked to identify the face they saw among morphed foils – two faces: one more Black than the original face and one more White than the original face – participants' responses depended on both their implicit lay theories and the racial label associated with the face. Entity theorists, who believe that traits are immutable, perceived and recalled the face as consistent with the racial label, whereas incremental theorists, who believe traits are malleable, perceived and recalled the face as inconsistent with the racial label. In a subsequent task, entity theorists drew a racially ambiguous target in line with the racial label presented, whereas incremental theorists contrasted their drawing away from the racial label presented. Importantly, the face they had to draw remained on the computer screen the entire time while participants completed their drawing. Thus, this drawing task more directly measured changes in online perceptual processing that occurred as a result of both context cues and perceiver characteristics.

Even dynamic cues in the face may serve as a context for interpreting ambiguous social memberships, and are likely to interact in concert with other cues, such as perceiver motivations. High-prejudice White perceivers are more likely to categorize angry, racially ambiguous targets as Black (Hugenberg & Bodenhausen, 2004; Hutchings & Haddock, 2008). However, this relationship was not present for happy racially ambiguous faces or low-prejudice perceivers. Thus, those that were particularly motivated to see a certain social affordance (Black = threatening = vigilance) utilized emotion to resolve racial ambiguity towards this affordance. Hugenberg and Bodenhausen (2003) showed that the converse relationship also holds – perceivers can use cues to a target's identity (i.e., race) and their implicit racial prejudice to resolve emotional ambiguity. High-prejudice White perceivers more readily saw anger in Black faces (e.g., saw anger as persisting longer in a Black face transforming from angry to happy or more quickly in a Black face transforming from happy to angry) than in White faces.

Other types of perceiver motivations may also interact with cues to a target's identity. Expectations of oneself as the target of prejudice (stigma consciousness) color individuals' interpretations of ambiguous emotions displayed on out-group faces (Inzlicht, Kaiser, & Major, 2008). Women high in stigma consciousness – those who chronically held an expectation of out-group rejection – saw contempt linger longer on a man's face than a women's face. Women low in stigma consciousness did not display the same biased interpretation of men's ambiguous emotional displays. Note that emotional ambiguity is resolved in a predictable, stereotype-consistent or expectation-consistent manner, which serves to justify the world-view of a high-prejudiced or high-stigma conscious individual. Thus, ambiguity is likely to be resolved in a manner that is functionally beneficial to the perceiver.

Beyond multiple contextual cues determining basic social perceptions, described above, we have recently provided evidence of how multiple category dimensions, that are typically theorized to be independent, actually *inter*-dependently interact (Freeman, Pauker, Ambady, & Johnson, 2008). Specifically, we reasoned that one category dimension could provide information about another, unrelated category dimension due to overlap in associated stereotypes. For instance, the identity "Male" may stereotypically convey aggressiveness, whereas the identity "Female" may stereotypically convey demureness. These stereotypes are not limited to categories of sex, however, as the identity "Black" may also convey stereotypes of aggressiveness and the identity "Asian" may also convey stereotypes of demureness. Thus, due to overlapping stereotypes between Male and Black sex/race categories and overlapping stereotypes between Female and Asian sex/race categories, perceptual cues that traditionally mark sex may also provide important information about race, and vice versa.

In one study, participants made sex categorizations of androgynous faces that were morphed continuously between Black, White, and Asian. As an androgynous face became more Asian (relative to White or Black), the probability of perceiving the faces as female increased. But as an androgynous face became more Black (relative to White or Asian), the probability of perceiving the face as male increased. Thus, to resolve ambiguity in sex, perceivers made use of markers of the unrelated category of race. It is therefore as if a Black androgynous face triggered the contents of the Black category, which, due to overlap with the Male category (e.g., "aggressive"), provided access to this sex category, in turn compelling the construal of the face as male. Moreover, these effects were moderated by perceivers' implicit associations between "Black" and "Masculine," and "Asian" and "Feminine," suggesting that a high-level cognitive blending between race and sex categories directed perceivers' basic perceptions. Thus, environmental associations between categories otherwise assumed to be unrelated (e.g., race and sex) can constrain perceivers' construals and provide top-down resolutions to social category ambiguity.

## IN ABSENCE OF SPECIFIC CUES

When cues are provided, perceivers evidently use them to resolve ambiguity, but what happens when the environment does not provide clear cues? As we have argued elsewhere (Pauker et al., 2009), it may be precisely when targets are truly ambiguous and no clear context cues are available to resolve this ambiguity that perceivers' motivations may hijack face processing. In addition to perceivers' motivations, other perceiver characteristics – such as their cultural knowledge – may also funnel perceivers' attunements towards particular construals. In particular, high-prejudiced perceivers tend to categorize racially ambiguous individuals into the out-group (Pettigrew, Allport, & Barnett, 1958) and take longer to make categorizations about ambiguous group members (Blascovich, Wyer, Swart, & Kibler, 1997). Similarly, perceivers who strongly identify with their in-group tend to over-exclude racially ambiguous individuals and take progressively longer to identify group membership as the likelihood of group membership increases (Castano, Yzerbyt, Bourguignon, & Seron, 2002).

Thus, different motivations affect the processing of racially ambiguous individuals. Prejudiced or highly identified perceivers tend to over-exclude racially ambiguous targets from their in-group. Additionally, those perceivers who are particularly concerned with determining correct group membership take longer to categorize racially ambiguous individuals, and those perceivers who are particularly concerned with protecting the in-group from potential contamination take longer to categorize targets as they become an increasing threat (e.g., closer resemblance to the in-group).

Similarly, Rule, Ambady, Adams, and Macrae (2007) found an egocentric bias in classifying men's faces as gay or straight that depended on perceivers' own sexual orientations. Although homosexual men were more accurate at discriminating gay from straight faces (see also Ambady et al., 1999), their advantage was largely due to heterosexual men's bias towards assuming that more faces were straight than gay. That is, heterosexual participants were much more likely to assume that targets were straight, rather than gay, perhaps because their exposure primarily consists of other straight, in-group members. Notably, this differs from other work (e.g., Castano et al., 2002) because Rule et al.'s (2007) heterosexual participants were not necessarily more homophobic than were their homosexual participants.

Indeed, homosexual participants were also biased towards assuming that targets were straight but significantly less so than were the heterosexual participants, perhaps also because of more frequent contact with straight men than with gay men. Given simple base-rates for the frequency of gay versus straight individuals in the population (see Savin-Williams, 2006), interactions with straight men should occur much more frequently than interactions with gay men. However, the geographic and social distribution of gay and straight men is not homogeneous. Rather, gay men are presumably more likely than straight men to have gay friends and acquaintances and to live and socialize in communities where contact with gay men is more frequent. Thus, although gay men are likely to have high contact with straight men by virtue of the greater prevalence of straight men in the population, they are also likely to have high contact with gay men, shifting their cultural knowledge base and informing intuitions about the number of gay and straight individuals to appear more equitable.

These differences in expectations might also be affected by motivation, however. Rule et al. (2007) found that gay men had better memory for the faces of men that they perceived as gay and straight men had better memory for the faces of men that they perceived as straight. The faces were encoded incidentally and participants were unaware that the targets systematically differed in terms of sexual orientation and were uninformed that there would be a subsequent test of memory for the faces. The observed differences in memory, then, suggest that perceivers allocated greater cognitive resources to the faces that they perceived to share their own sexual orientation versus the faces that they perceived to not share their sexual orientation. Greater attention and deeper processing for faces incidentally and unintentionally perceived as gay and straight might also influence perceivers' experiences of contact with in-group and out-group targets. That is, gay men may be more likely to "see" other gay men and straight men may be more likely to "see" other straight men because they are motivated to attend to their own group.

## CANDIDATE MOTIVATIONS IN ABSENCE OF CONTEXTUAL CUES

We argue that people may be particularly likely to rely on internal motivations, goals, and cultural associations when faced with perceptually ambiguous targets and no other contextual cues to resolve this ambiguity. A number of researchers have discussed the potential for ambiguity to act as a trigger for motivational influences (e.g., Bruner & Goodman, 1947; Festinger, 1954). Perceivers may experience a certain discomfort with ambiguity, particularly with regard to ambiguous social categories. Uncertainty about something that is subjectively important, such as determining group membership or the signal value of a particular emotion (e.g., whether someone is approaching to attack or befriend you), elicits a greater impetus to resolve this ambiguity (Hogg, 2000). Determining group membership serves an important adaptive function (Cosmides, Tooby, & Kurzban, 2003) and ambiguous social category members pose a potential threat to clear group boundaries, eliciting a motive for in-group protection (Tajfel & Turner, 1979). As such, this may affect how ambiguous group members are categorized – often in a way that sets a high bar for inclusion into the in-group. Others discuss the need to reduce uncertainty as a fundamental human motivation (Heine, Proulx, & Vohs, 2006; Hogg, 2000; Mullen & Hogg, 1999), ultimately reflecting a need for organized and predictable meaning in the social world. In fact, perceivers' tendencies to resolve ambiguity in a self-serving manner, so as to see the world in a particular way, may serve as one potential mechanism for humans to construct a meaningful, predictable world.

## DOWNSTREAM CONSEQUENCES

We have reviewed evidence that contextual cues, cultural associations, and perceiver motivations may affect perceptual processing of faces across several stages in visual perception, particularly with increasing perceptual ambiguity of the target. These differences in perceptual processing lay the foundation for potential downstream differences in higher-order cognition and behavior. One area where differences in face perception could have direct downstream consequences is facial recognition memory. A plethora of studies has shown that people have difficulty recognizing and remembering faces of a race that is not their own, a tendency referred to as the own-race bias or other-race effect (e.g., Malpass & Kravitz, 1969; Meissner & Brigham, 2001). This bias may be part of a larger collection of memory biases in which members of the in-group are remembered better than members of the out-group (Anastasi & Rhodes, 2006; Bernstein, Young, & Hugenberg, 2007; Huart, Corneille, & Becquart, 2005; MacLin & Malpass, 2001; Rule et al., 2007; Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008; Shutts & Kinzler, 2007; Wright & Sladden, 2003). In the case of ambiguous group membership, perceivers may utilize available context cues or motivations to disambiguate group membership and subsequently direct their attention when encoding the face. MacLin and Malpass (2001), for instance, found that stereotypical hairstyles actually altered perception of facial features, resolving racial category membership, and subsequently affecting memory. Thus the same racially ambiguous face was better recognized when paired with an in-group stereotypical hairstyle as opposed to an out-group stereotypical hairstyle. Other studies have also demonstrated that context cues attached to gender ambiguous or racially ambiguous faces can guide recognition of these faces such that individuals exhibit superior recognition of faces tagged as in-group members (Huart et al., 2005; Shutts & Kinzler, 2007). These differences are likely to take effect at the stage of perceptually encoding the face, as context cues provided after face encoding (Huart et al., 2005, Study 3) had no affect on face recognition.

When no context cues are provided, individuals may rely on motivations and cultural associations to disambiguate group membership. How these perceptually ambiguous social categories are resolved directly impacts memory. The emphasis of past research on unambiguous and easily identifiable group identities has obscured the role of motivational factors in social memory, which may exert their influence at the stage of deciding who is an in-group or out-group member. In distinction, the examination of memory among perceptually ambiguous groups has shown reliance on initial, independently variant perceptions. For instance, Rule et al. (2007) found that gay and straight men had better incidental memory for targets that they believed to be in-group versus out-group members, independent of the targets' actual group membership. Thus, perceivers' initial impressions of who is an in-group or out-group member during encoding directly influenced their subsequent memory for faces, favoring individuals perceived to be in-group members.

In the case of another naturally ambiguous category, Pauker et al. (2009) found that memory for biracial targets was limited because of insufficient motivation to include these "fringe" individuals into the in-group. Both Black and White participants misremember racially ambiguous Black/White faces, recognizing ambiguous faces more poorly than prototypical, in-group faces; however, these memory decrements were eliminated with the experimental increase of inclusion motives during encoding. These inclusion motives increased the likelihood that ambiguous faces would be associated with the in-group and only as a consequence of this effect was memory for ambiguous faces improved. However, the influence of motivations only appeared to influence memory when these faces were perceived as ambiguous. When motivational processes were "short-circuited" through the use of context cues (e.g., racial labels), participants recognized the faces in line with the labels. Perceivers' use of such context cues may also be moderated by perceivers' lay theories regarding the nature of groups. Biracial individuals tend to think of groups more flexibly and this belief allows them to recognize multiple racial groups and ignore theory-violating context cues. Thus, biracial individuals, who think of race in a more flexible manner, largely ignore labels when remembering biracial faces (Pauker & Ambady, 2009). On the other hand, monoracial individuals, who tend to think of groups in a more essentialized fashion, search out theory-consistent context cues that allow them to clearly categorize racially ambiguous individuals. Consequently, monoracial individuals rely heavily on labels that indicate who is in-group and out-group when remembering biracial faces.

In sum, perceivers' attunements shape how they process context cues to resolve ambiguity, which subsequently directs social memory. Even exactly the same face can be highly recognizable or ignored depending on the initial perception of whether this face is a "friend or foe." Thus, in the fleeting moments of catching sight of a face and recognizing its group membership, this initial process of ambiguity resolution can fundamentally impact downstream processes, resulting in diverging outcomes for those perceived as in-group or out-group members.

## IMPLICATIONS FOR SOCIAL POLICY ISSUES

The studies we have described highlight that environmental contexts and even perceiver motivations may influence perception, especially when there are no obvious category labels or social-identity cues available. Thus, people may often perceive what they want to see in the case of ambiguous social categories, leaving many social perceptions open to self-serving biases and stereotypes.

Moreover, this chapter highlights the perceptual fluidity possible in a number of ambiguous social categories. Additionally, this perceptual fluidity is reflected in downstream processes, such as memory, and underscores the role that perceived group membership can play in this process. Just the perception that a target belongs to a specific group can drastically alter memory for that target, which has obvious ramifications for legal issues, such as eye-witness identification (MacLin, MacLin, & Malpass, 2001; Meissner & Brigham, 2001). Although using social category labels to formulate a description of a perpetrator can be useful, an over-reliance on such labels can guide facial recognition in predictable and often biased ways. As such, care should be taken when utilizing social category labels in a criminal justice setting, particularly when a perpetrator's social category membership may be ambiguous.

These factors also play a role in laws and social policies that deal with differential access to resources between social groups. For instance, much of the debate concerning same-sex marriage rights concerns the ambiguity of boundaries between who is gay and straight. A recent mainstream film entitled *I Now Pronounce You Chuck and Larry* exemplifies this conundrum. In the film, two male characters pretend that they are gay lovers to gain domestic partner benefits. This typifies the argument that because sexual orientation is perceptually ambiguous it is difficult to prevent individuals from claiming category membership as either gay or straight for personal gains. Thus, some opponents of same-sex marriage have argued that legalizing same-sex marriage would allow an additional opportunity for people to take advantage of rights extended exclusively to married couples, similar to the characters' behavior in the film.

Similar circumstances occur for multiracial individuals. Persons with multiple racial heritages may be denied access to programs designed to support traditionally disadvantaged minority groups. One key example of this might be gaining membership to particular Native American tribes. Many American Indian nations have adopted specific and strict criteria for the level of genetic heredity needed for an individual to be granted membership in the tribe. This can affect access to funds provided for reparations by the US government, as well as access to programs designed to benefit Native Americans, who are socioeconomically disadvantaged in the US. Similar issues may arise for opportunities afforded to underprivileged minority group members via affirmative action programs and in legal cases involving racial discrimination. These issues highlight the potential for divergent social outcomes based on perceived group membership, and the potential for motivation to tinge decisions of the group into which an ambiguous-category member will be placed.

## CONCLUSIONS

Examining ambiguous social categories highlights that aspects of person perception, such as the perception of social categories from facial cues, may be informed through a socially adapted lens. How we see an individual may depend in part on what we want to see or how our environment directs us to see it. Higher-order social cognition (e.g., personal motivations, cultural associations, and contexts) collaborates with bottom-up perceptual operations to negotiate what we ultimately see. Our argument is not meant to suggest that higher-order social cognition does not play a role in the perception of non-ambiguous stimuli (see Brinsmead-Stockham, Johnston, Miles, & Macrae, 2008; Johnston, Arden, Macrae, & Grace, 2003 for examples of motivation affecting sensitivity to clear social categories), but merely that it is particularly likely to play a role in disambiguating ambiguous stimuli. Increasing ambiguity is likely to motivate increasing reliance on top-down factors to reduce this ambiguity. In part, perceivers' tendencies to resolve ambiguity in a self-serving manner may facilitate their construction of a meaningful and predictable world. Overall, this exciting line of research underscores the importance of examining how the social world fundamentally impacts what we see, and how we might construct the world as we want to see it.

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# 2

# Motivation across Time and Place: What Gaze Can Tell Us about Aging and Culture

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Recent social psychological evidence suggests that people may see "what they want to see" (e.g., Balcetis & Dunning, 2006), but such findings prompt the question: what do people want to see? In this chapter, we argue that what someone wants to see (and does see) is not simply a state of being, but rather it varies systematically as a function of between-person variables such as age and cultural background. In other words, while vision can certainly be affected by state motivation, traits that vary between groups can also guide visual processing. We use studies of fixation to test for differences between groups in what aspects of visual stimuli are more or less attended to. These studies point to motivation as a powerful guide for gaze, and suggest that gaze can tell us about underlying motivational states of perceivers as they interact with their environment. In particular, we will show in this chapter that motivation related both to age and to culture, to time and to place, can influence perceivers' visual processing of their environment.

What, though, do we mean by the term "motivation"? Heinz Heckhausen defined motivation as "a global concept for a variety of processes and effects whose common core is the realization that an organism selects a particular behavior because of expected consequences, and then implements it with some measure of energy, along a particular path" (Heckhausen, 1991, p. 9). Several things are important about this concept of motivation: first, it is clearly general and amenable to many different types of goal pursuit. But critically, it locates interactions with the environment and behavioral choices in the context of goals an organism is pursuing. In other words, humans are not passively interacting with the world around them, but instead are proactively trying to get what they want in their on-line perception, cognition and behavior.

This leads us to the next question, which is: why study gaze patterns as a way of understanding motivation? On the most mundane level, using gaze patterns as a dependent variable in the study of motivation provides a more implicit measure of what is guiding an individual's interactions with the world than simply asking them about their goals. But even among non-self-report measures, fixation can provide information on processing above and beyond measures like response accuracy (Griffin, 2004) and dot-probe (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a). Gaze is sensitive to individual differences such as optimism (Isaacowitz, 2005; Luo & Isaacowitz, 2007), and below we describe our attempts to use the study of gaze to move beyond simply documenting individual differences to using them to understand how goals direct perceivers' interactions with their environment.

## WHAT DO PEOPLE WANT, AND HOW DOES IT CHANGE ACROSS ADULTHOOD?

Life-span developmental psychologists have long been interested in motivation, as a way of understanding how individuals shifted their investment in different domains as they got older. The underlying rationale has been that well-documented changes in physical and cognitive abilities with advancing age constrain the older individual's abilities to pursue all possible goals; thus, the notion of selectivity, or the prioritization of some goals over others, has been key to life-span developmental models of motivation. The most general of such models, Selective Optimization with Compensation (SOC: Baltes & Baltes, 1990), posits that successful goal pursuit at any age requires an orchestration of goal-relevant processes, but that this orchestration becomes more essential to adaptive functioning given the resource limitations of advancing age.

The three component processes according to the SOC model are: selection of some goals to pursue over others, optimization of available resources in support of those goals, and compensation when available resources are not sufficient to achieve the goal. Utilizing these processes is assumed to make goal accomplishment more likely, and studies have found that endorsement of SOC-related items on self-report measures correlates positively with well-being, even after controlling for other possible influences (Freund & Baltes, 1998). Although the original formulations of the model were neutral concerning the content of goals, more recent work in the SOC tradition has proposed that age changes in opportunities and constraints make it adaptive for younger adults to focus on growth-oriented goals, whereas older individuals are best off if they select goals related to maintenance of abilities and avoidance of loss (Ebner, Freund, & Baltes, 2006). Relatedly, older adults appear to prefer process-oriented goals over outcome-oriented goals (e.g., Freund, Riediger, & Hennecke, in press). In one experiment (Freund et al., in press, Study 2), older and younger adults completed a "thought exercise" in which they were instructed to focus their attention on either the process or outcome of achieving goals. Older adults felt better (more positive affect) when they were instructed to focus their attention on the process of goal attainment than when they were instructed to focus their attention on the outcome. Though mostly not explicitly concerned with attention and vision, work growing out of the SOC model on age differences in goal pursuit suggests that one answer to the question of what people want to engage with is information that will help them to pursue selected goals and optimize their attempts to accomplish those selected goals.

A related but distinct life-span approach to motivation is the model of Optimization in Primary and Secondary Control (OPS: Schulz & Heckhausen, 1996). According to this model, selection and optimization are key, but the overarching motive underlying goal pursuit is considered to be the achievement and maintenance of control over the environment. Primary control strivings involve attempts to modify the external world, whereas secondary control strivings target internal psychological states. An important facet of the OPS model is the importance of disengagement from goals that are no longer likely to be achieved: Continued attempts to accomplish these unlikely goals will detract resources from domains where control is possible, and thus are maladaptive. Constraints on primary control caused by physical changes and social barriers dictate that older adults must rely more on secondary control strivings to maintain as much primary control as is possible (Schulz & Heckhausen, 1996).

The OPS model of motivation has been linked conceptually as well as empirically to attention and information processing. In one study, childless women who were or were not past the developmental deadline for having children completed an incidental memory task involving sentences about children, among many other measures. In addition to showing the hypothesized pattern of goal strivings (women who still could have children were more engaged with that goal than women who had passed the deadline), women who still could have children showed superior recall for child-relevant sentences (Heckhausen, Wrosch, & Fleeson, 2001). This finding suggested that goal disengagement processes proposed by the OPS model would be revealed in goal-relevant information processing regarding memory, and that these information processing patterns serve to help the perceiver disengage from unlikely goals and focus primary control efforts on goals that were more likely to be accomplished. The overall effect of this would be the adaptive maintenance of optimal levels of primary control in the face of declining resources.

We wondered whether such effects would also be found in goal-relevant attentional processing. To investigate this, we presented images of human babies, along with equally cute pictures of puppies and kittens (as well as pictures of chairs), to similar samples of childless women in their 20s and early 30s (pre-deadline), and a group in their 40s (post-deadline). While advances in medical technology have produced cases of childbearing well past that, there remains a perception that childbearing becomes substantially more difficult after age 40 (e.g., Heckhausen et al., 2001).

We found very similar fixation patterns in the two samples, with one subtle but important difference: the post-deadline women had significantly shorter first fixations to the human baby pictures than did the pre-deadline women. No such differences emerged for any of the other stimulus types, including the cuteness-matched puppy or kitten images. These findings suggest that visual processing of stimuli can be guided by the motivational processes specified by the OPS model, and critically, that fixation patterns could be part of perceivers' efforts to disengage from some goals in favor of others (Light & Isaacowitz, 2006). Thus, one way of answering the question of what is it that people want to look at may be that they look at stimuli in a way that will help them achieve goals and optimize the primary control they exert over their environment.

A third life-span model of motivation shares a focus on selectivity with the SOC and OPS models, but makes more specific claims about the content of goals and how they change with age. Socioemotional Selectivity Theory (SST) asserts that shifts in time perspective that tend to occur with age also impact goals (Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999). Those with a limited time perspective are hypothesized to pursue goals related to emotion regulation and optimizing affect. Older adults therefore may be selective in their social relationships in order to focus only on those relationships that are emotionally rewarding (Fung, Carstensen, & Lang, 2001). Those with a more open-ended time perspective (i.e., younger adults) should prefer goals that will be of benefit in the future, such as gaining information, even if it interferes with current affective experience. While SST can be considered a "specific case" of the SOC model (Baltes & Carstensen, 2003), it does not share the OPS model's claim that maintaining control is paramount; nor does it share with the SOC model the versatility to apply to pursuit of any goal. Thus, SST shares some similarities with the other theories, but also is quite distinct.

Although SST was originally focused on understanding the social choices made by older adults (Fung, Carstensen, & Lutz, 1999), with emotion being a rationale for those choices, the theory was also used to understand surprising findings from self-report (e.g., Mroczek & Kolarz, 1998) and experience sampling (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) suggesting that older adults report positive affective experiences. The socioemotional selectivity theory explanation for this pattern of findings is that older adults pursue goals of regulating how they feel; in other words, they feel good because they are motivated to care about feeling good (Charles & Carstensen, 2007).

## HOW DOES MOTIVATION IMPACT VISUAL PROCESSING IN AGING?

More recently, the motivational approach of SST has been extended into the domain of information processing, based on the logic that older adults' pursuit of emotion regulatory goals should also be revealed in their cognitive processing of the world around them. Perhaps not surprisingly then, this approach has led to the bulk of research on motivated processing and aging. Whereas early research on this question suggested an emotion salience effect, whereby older adults were more attuned to the emotional content of material in their environment (Carstensen & Turk-Charles, 1994), other work found a "positivity effect" whereby older adults appeared to preferentially process positively valenced as compared to negatively valenced stimuli (Carstensen & Mikels, 2005). For example, Charles, Mather, and Carstensen (2003) found that older adults seemed to delete negative emotional images from their memory, whereas younger adults' memory for emotional images did not differ as a function of the images' valence.

Although much research on age-related positivity effects has centered on memory (e.g., Kennedy, Mather, & Carstensen, 2004; cf. Gruhn, Smith, & Baltes, 2005; Murphy & Isaacowitz, 2008), several studies have investigated whether older adults' visual processing may reflect their motivation to regulate affect. One study used a dot-probe methodology (Mather & Carstensen, 2003) to determine whether older and younger adults displayed different attentional preferences to faces varying in the valence of their displayed expressions. Dot-probe tasks assess attentional biases based on reaction times when probes appear immediately behind emotional or neutral faces; an attentional bias to the emotional face is indicated by faster reactions when the probe appears behind the emotional as opposed to the neutral face. Based on measures of reaction times, it appeared that older adults showed an attentional bias to neutral faces when they were paired with negative faces, and to positive faces when they were paired with neutral ones.

The Isaacowitz lab has used eye tracking to further document and explain age differences in visual processing of emotional stimuli. Starting with SST's assertion that there may be "positivity effects" in older adults' information processing (Carstensen & Mikels, 2005; Carstensen, Mikels, & Mather, 2006), we conducted two descriptive studies testing for age differences in fixation to images varying in emotional valence. Given our interest in determining whether there are age differences specifically in fixation to emotional stimuli, it was important to use target stimuli that did not include perceptual features that might be processed differently by individuals of different ages. Vision research has shown that older adults have particular challenges with perceptual properties such as contour and luminance (e.g., Sekuler & Sekuler, 2000). Thus, we sought stimuli that varied in valence (positive vs. negative vs. neutral) but not in these other features, in order to isolate specific age effects on emotional processing. This led us to "Wilson faces" – a set of synthetic faces developed by Hugh Wilson using facial geometry in which features such as luminance and contour were controlled (Wilson, Loffler, & Wilkinson, 2002). The faces were created devoid of emotional expression, and then Ekman's description of the facial characteristics of the expressions of anger, fear, sadness, and happiness (Ekman & Friesen, 1975) were applied to each face, also using facial geometry to preserve the psychophysical controls.

In two studies, older and younger viewers were presented with pairs of faces; in each pair, one was an emotional expression (happy, fear, angry, sad) and one was a neutral non-emotional expression, but both faces were of the same "individual." In one study, participants were simply asked to watch the face pairs "naturally, as if at home watching television." Young adults showed a preference towards the fear faces, whereas older adults looked away from the angry faces and towards the happy ones in the emotional-neutral face pairs (Isaacowitz, Wadlinger, Goren, & Wilson, 2006b). In a second study, the eye tracking (to happy-neutral and sad-neutral face pairs) was combined with a dot-probe task, a widely-used "traditional" measure of attentional bias. In this case, the older adults looked towards happy and away from sad faces, while the young adults showed only a slight preference away from the sad faces; eye tracking revealed a more robust preference pattern than did the dot-probe. Together, the studies suggest that older adults show a positive preference in their gaze patterns towards emotional faces, looking towards positive and away from some types of negative stimuli under free viewing conditions. This seems generally consistent with proposals for age-related positivity effects in information processing (e.g., Carstensen et al., 2006) arising from socioemotional selectivity theory.

A number of questions related to motivation emerged from these interesting descriptive findings, related to whether motivation generally could produce such a pattern of gaze preferences, and whether the specific motivational processes specified by socioemotional selectivity theory could be linked to gaze patterns as well. We describe studies conducted to investigate these two questions below.

First, we attempted to discern whether the positive gaze preferences, towards positive and away from negative, shown by older adults could be attributable to motivational shifts at all. To do this, we first attempted to rule out what would be the most likely suspect for confounding observed age effects: namely, whether changes more generally in cognitive and perceptual functioning between young and older adults could produce the pattern of emotional processing we observed. If that was the case, then motivation would not be a plausible explanation for them. Using data from the two descriptive studies described above (Isaacowitz et al., 2006a, 2006b), we used participant and statistical matching to determine whether observed gaze patterns could be attributable to attentional functioning, or fluid or crystallized intelligence abilities. In both cases, controlling for individual differences in these variables did not change the gaze results, supporting the idea that specific gaze patterns to emotional processes are not simply side-effects of more general cognitive aging processes.

We next conducted several lab studies of younger adults in different motivational conditions, testing whether we could recreate older adults' positive preferences in these young adults. Not only would this remove the cognitive age confound altogether, but it also could bring us closer to understanding *what* motivational states could lead to such fixation patterns. In the first such study (Pruzan & Isaacowitz, 2006), we tested for differences in gaze patterns between college first-years and graduating college seniors. We used this design because of earlier work in the SST literature finding that graduating college seniors share with older adults a sense of time limitations (Fredrickson, 1995), highlighting that advanced age is not the only context in which time may be perceived as limited. We found that those young adults with a more limited time perspective due to impending college graduation looked similarly at positively valenced images as did their first-year peers, but they looked less at negatively valenced images compared to those with a more expansive time perspective.

In a follow-up study, we randomly assigned college student participants to view images varying in emotional valence under one of three instructional conditions: one was a control condition, one was intended to mimic the presumed motivational state of young adults according to SST by asking participants to try to gain as much information as possible from the images, and the final condition mimicked the motivation of older adults by instructing participants to try to manage how they felt as they viewed the images. Similar to the previous study, those young adults given the motivation to regulate how they felt looked less at negative images compared to the other groups (cf. Handley & Lassiter, 2002; Lassiter, Koenig, & Apple, 1996). In addition to their specific lessened fixation to the negative, the group instructed to the motivational state of older adults also showed less fixation overall than did participants in the other groups, suggesting that they were trying to “not look” as a way of regulating how they felt.

The results of these two studies together suggest that manipulating motivation can indeed have an impact on fixation patterns, and that these effects provide some support for SST’s assertion that motivational shifts can lead to positive preferences. However, it is notable that across both studies, motivation reduced fixation to negative stimuli but did not increase fixation to positive stimuli; therefore, only part of older adults’ fixation patterns could be re-created in younger adults by motivating their manipulation. This suggests that goals related to mood regulation could plausibly be part, but perhaps only part, of the etiology of older adults’ positive fixation preferences.

Another way that we have tested whether motivation could be a plausible cause for older adults’ gaze preferences has been to investigate their time course. By investigating when after the onset of stimulus presentation gaze preferences emerge, some information can be gathered about what causes of the preferences are more or less likely. For example, immediate onset of gaze preferences would implicate bottom-up/stimulus-driven causes, which are thought to emerge more rapidly in visual processing than do top-down/goal-driven influences (e.g., Mogg & Bradley, 1998). To investigate this, we decomposed fixation data from the Isaacowitz et al. (2006b) study into 500 ms intervals, starting with stimulus onset (analyses presented in that paper summed over the entire interval of stimulus presentation). This decomposition was done for one positive (happy) and one negative (angry) emotion type. Results indicated that preferences did not emerge within the first 500 ms, though they started soon thereafter for happy, and a few seconds later for angry. In both cases, the magnitude of the preference in the older group (towards happy, away from angry) increased over time. While this time course does not definitively illustrate that the age-related gaze preferences emerge due to top-down influences, it nonetheless does present a temporal picture that is consistent with goal-directed influences on visual processing (Isaacowitz, Allard, Murphy, & Schlangel, 2009).

## DO MOTIVATED GAZE PREFERENCES HELP OLDER ADULTS REGULATE THEIR MOOD?

Despite the evidence above, establishing a clear link between mood regulatory goals and older adults’ positive gaze preferences still faced an important hurdle: namely, demonstrating that the fixation actually was used in pursuit of mood-regulatory goals. Demonstrating this would entail not only showing that positive gaze preferences are activated when older adults are in a context in which they need to regulate their mood, but also that the preferences actually serve to improve or regulate the mood of the perceiver using them. That type of evidence would provide a functional account of older adults’ gaze preferences that could support SST’s account of why such an age-related positive preference exists.

To pursue these issues, we recently conducted a study in which we used mood induction to try to vary the mood state of younger and older participants. The goal of this was to create a context in which some participants in each age group were in a negative mood which they presumably would want to regulate themselves out of, into a better mood. We selected the Continuous Music Technique, developed by Eric Eich (CMT: Eich & Metcalfe, 1989), in which participants are asked to self-induce, with the help of music, into a high arousal positive, high arousal negative or neutral mood state. Participants were left alone with an affect grid and were asked to move a cursor to indicate their current mood within a two-dimensional valence-by-arousal space. When the experimenter noted (remotely) that the participant had been within the target quadrant for at least 30 s, indicating successful induction to the target mood, the induction was ended and the participant was moved to the eye tracker.

At that time, participants were calibrated and instructed on how to record their mood continuously during the eye tracking procedure. A one-dimensional valence rating was used on a potentiometer slider to permit ratings without interfering with the tracking. Initial mood ratings suggested variability in the sample, but not always matched with the assigned mood condition; in other words, it appeared that some participants had already regulated their mood by the time they had moved seats. One participant gave a very positive slider rating after having just a moment earlier reported being in a very negative mood due to the negative mood induction procedure. When that participant was queried after the study about the quick shift from the induced negative mood to a very positive mood almost immediately after the end of the induction, the participant reported that she rated herself so happy because she was so relieved at the induction being over!

Given our interest in the use of gaze for mood change, we elected to divide the sample based on their mood at the start of the eye tracking rather than based on randomly assigned mood induction condition. We found distinct patterns of fixation to the emotional faces by age and mood at the start of eye tracking. (see Figure 2.1). Among those participants who came to the eye tracking task in a good mood, the young adults showed mood-congruence in their gaze (looking more at happy faces), whereas older adults in good mood showed no significant preferences towards or away from the emotional faces. A similar pattern was found among those who came to the eye tracking in neutral moods, with young adults looking more at happy faces and older adults showing no significant gaze preferences.

The story was quite different, though, among those participants who came to the eye tracking task in a bad mood. Among those young adults in negative moods, they looked more at negatively valenced faces; in other words, young adults showed gaze that was congruent with their negative mood. In contrast, older adults who started the eye tracking in a bad mood looked more at happy faces and away from negative ones, demonstrating a mood-incongruent positivity in their gaze (Isaacowitz, Toner, Goren, & Wilson, 2008). Two important conclusions can be drawn from these findings: first, the mood-congruent processing shown in younger adults' memory (e.g., Mayer, McCormick, & Strong, 1995) is also found in their gaze patterns; and second, older adults do not show mood-congruent

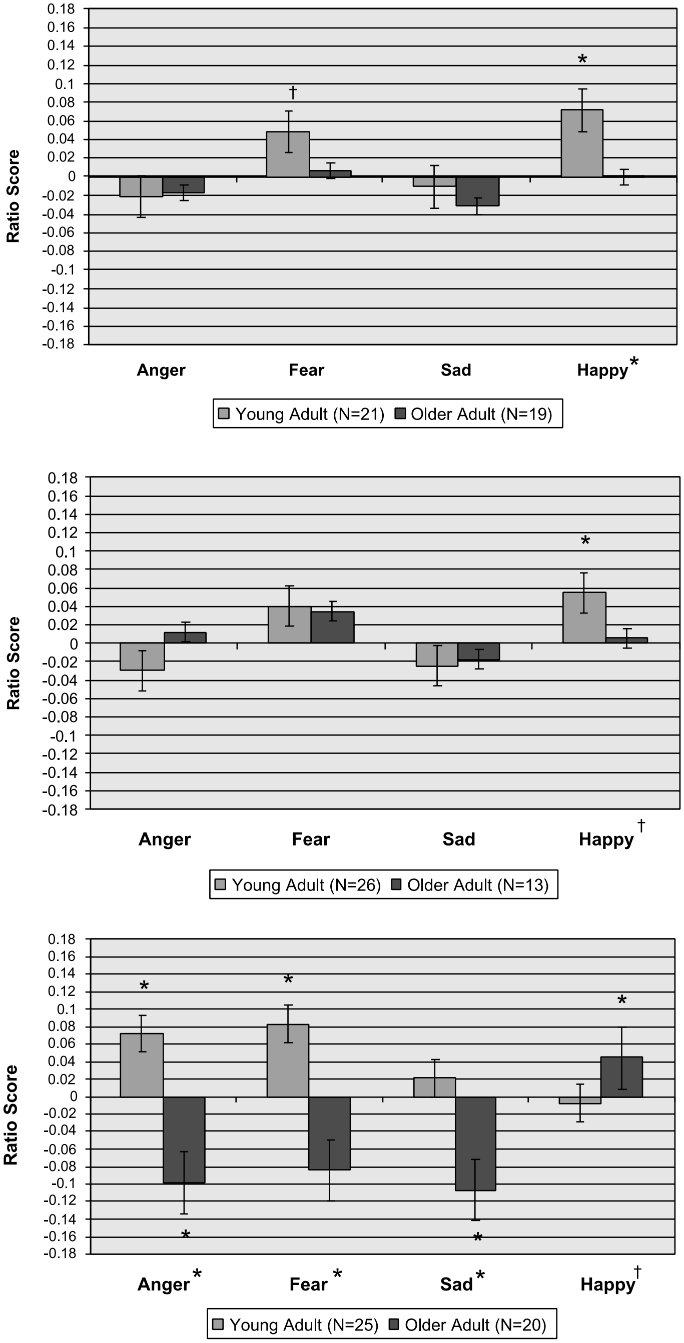

FIGURE 2.1 Fixation preference ratios to emotional face stimuli, by age group, for participants starting in a positive mood (top), a neutral mood (center), or a negative mood (bottom). Notation of significance next to a bar is for the *t* test evaluating whether the ratio score for that cell is significantly different from zero, and notation next to the emotion type is for the test of the between-groups age difference (from Isaacowitz et al., 2008 with permission from Wiley-Blackwell).

gaze. Rather, they activate mood-incongruent positive gaze preferences when they are in bad moods, supporting the hypothesis from SST that older adults use positive processing preferences to help them regulate their mood. For young adults, gaze appears to more simply reflect the mood they are in rather than being a tool used to regulate mood. Perhaps one thing that individuals learn – with the experience that comes from getting older and having repeated experience in regulating emotions – is how to transform gaze from a symptom of mood to a tool to change it (Isaacowitz et al., 2008).

Although the above results demonstrate that older adults activate positive gaze preferences in contexts in which they need to regulate their moods, that is only one part of the functional account offered by SST for why such preferences exist. The other critical piece would be to determine whether the positive gaze preferences "work"; in other words, do they in fact help to improve the mood of the perceiver using them? There was limited evidence linking positive biases in autobiographical memory to better mood in one condition of a larger study (Kennedy, Mather, & Carstensen, 2004), but direct evidence connecting attentional preferences to mood change was lacking. To investigate this, we looked at the real-time coupling of fixation preferences and mood change in our participants. We used two-minute intervals during the overall 20+-minute eye tracking to assess whether gaze preferences impacted mood change; we focused on these microlevel time increments as well as the overall mood change due to general fatigue effects in the sample.

In addition to simply mapping links between gaze and mood (asking the question, do people feel better when they gaze more positively?), we also asked whether these links varied as a function of age. We hypothesized that mood improvement would be related to positive gaze preferences (towards positive, away from negative) in both groups, and vice versa for negative. However, we expected that fixation patterns to positive would be more predictive of mood change for the older adults, whereas fixation to negative would be more predictive for the young. In addition, recent work by Mara Mather suggests that older adults' ability to utilize motivated positivity effects in their information processing requires considerable cognitive resources, particularly involving cognitive control (a "cognitive control" account), such that individuals with compromised abilities (due to either person-level effects or task demands) cannot display such preferences (Knight et al., 2007; Mather & Knight, 2005). Given our focus on the use of visual attention, we thought it made sense to consider individual differences in processing abilities in the attention domain. We therefore used the Attention Network Test (ANT: Fan, McCandliss, Sommer, Raz, & Posner, 2002) to assess individual differences in three attentional processes: alerting, orienting, and executive control. The ANT is an experimental task combining spatial cueing and flankers; participants respond to the directions of arrows (left or right) in the presence or absence of various types of cues. Comparing performance on differential trial types yields scores on three attentional networks: alerting, orienting, and conflict. Higher scores on the conflict network indicate worse executive control, whereas higher scores on the alerting and orienting networks occur when individuals benefit a lot in terms of their reaction time from the presence of cues, as their performance is faster when given a temporal (alerting) or spatial (orienting) cue. In regression analyses on mood change during the entire task, older adults with good executive function were able to stave off mood declines when they showed positive gaze preferences (Isaacowitz, Toner, & Neupert, 2009).

Multilevel modeling was used to test for interactions between age, fixation patterns and attentional abilities in the prediction of mood change within 2-min intervals. We expected that executive control would be the most strongly related to fixation-mood change links, following the cognitive control account. Alerting and orienting scores were considered also, though these were not the foci of our hypothesis-testing. To our surprise, no effects emerged for executive control. Instead, several interactions were found involving the alerting and orienting networks. Of most interest was the finding that older adults higher in alerting or orienting scores felt best when they looked less at sad faces, whereas those lower in alerting or orienting felt best when they looked more at sad faces (Isaacowitz, Toner, Neupert, & Choi, 2010).

To decompose the nature of this effect, one must first consider the meaning of higher and lower scores on the alerting and orienting networks. Scores are calculated as the boost a participant gets from an alerting or spatial cue as compared to their performance without the cues. In the context of aging, higher scores have been interpreted as reflecting either a difficulty in sustaining attention in resting states with no external cues, or a conservative response strategy (Fernandez-Duque & Black, 2006). For example, a participant whose resting, internal alertness is low, but who responds vigorously in the presence of an external cue, would score high on the alerting network even though their resting alerting level is low. Indeed, older adults have been found to rely more on external cues than do the young (Spieler, Mayr, & LaGrone, 2006). Regardless of the interpretation, a higher score on alerting and orienting is indicative of a participant benefiting more from the presence of cues. Thus, those older individuals who are most helped by the presence of cues are also the ones for whom positive gaze preferences help them feel better in short intervals.

What, though, are the cues that these older adults are responding to? One possibility is that older adults can use the presence of emotionally valenced stimuli as an alerting cue that mood regulation may be relevant in that context. In other words, an older adult who is not being particularly alert may wait for a sign from their environment that they need to engage in mood regulation, and the presence of emotionally relevant stimuli may serve as that signal. An older adult who is usually fairly alert may still wait for cues to shift their focus away from what they are doing in order to regulate their mood. In either case, they may then mobilize their gaze preferences and can successfully regulate how they feel. This may be considered a "lazy" strategy, but it can be adaptive, insofar as it can indeed serve to protect mood. Using gaze to regulate mood may work, but it is risky: it may have a high "false positive" rate in which non-negative or negative but important information in the environment may be missed. For example, someone using gaze to regulate their mood may look briefly at a list of recalled products and quickly decide that none of the products that they use are included on the recall list – making them feel relieved – when a more careful scan of the list would illustrate that one product that they use regularly is actually on it.

If the use of gaze to regulate mood by older adults is a "cheap" strategy, it should not only be favored by those with lower resting alertness, but also should be possible under some types of distraction. One study seems to speak against this possibility: Knight et al. (2007) found a reversal of positive gaze preferences, to an actual preference for the negative, when older adults had their attention divided. However, that study utilized a very demanding distractor task, likely leaving participants no opportunity to engage in any mood regulatory processes at all. In contrast, we recently completed a study in which gaze preferences were investigated with a less distracting divided attention task (Allard & Isaacowitz, 2008). In this case, older adults were able to display positive gaze preferences even when their attention was divided. It seems somewhat logical that positive gaze preferences would not be displayed with high levels of distraction; for example, it is hard to imagine that only looking at positive stimuli while surrounded by a natural disaster would be an adaptive process. But, being able to maintain such positive gaze preference with some distraction, like the television on or someone talking nearby, should be adaptive for the older adult perceiver.

## MOTIVATION, AGING, AND THE RECOGNITION OF EMOTIONS IN OTHERS

We have also investigated whether motivational influences on gaze influence emotional processing not in terms of the perceivers' regulation of their own affect, but instead in terms of their ability to recognize emotional responses in others. Given the gaze preference findings described above, one might hypothesize that older adults are particularly accurate in identifying positive emotional expressions in targets, and that they are impaired in identifying negative expressions. Some work has supported this conclusion (e.g., Brosgole & Weisman, 1995). Indeed, a recent meta-analysis concluded that there were robust age differences such that older adults consistently perform worse in their accuracy of identifying anger and sadness, whereas impairments in recognizing happiness were not as strong (Ruffman, Henry, Livingstone, & Phillips, 2008). However, one problem with findings of no age differences in accuracy in recognizing positive expressions is that there is usually only one positive expression – happy – and it is so easy to detect that performance tends to be at ceiling in all age groups. Such findings should not really be taken as indication of an age-related maintenance in abilities. When the task is made more difficult, for example by adding different types of positive emotions beyond just happy, older adults perform worse even in the identification of positive emotional expressions (Isaacowitz et al., 2007).

Despite the fact that the age differences in emotion recognition do not exactly mimic the age differences in gaze towards emotional faces (in non-recognition tasks), it has still been of interest whether gaze patterns could contribute to older adults' apparent recognition deficits. Several studies have suggested that older adults do not fixate enough on the eye region when viewing emotional faces, and that this may cause their deficit in emotion recognition accuracy (Sullivan, Ruffman, & Hutton, 2007; Wong, Cronin-Golomb, & Neargarder, 2005). As these findings were based on simple correlations between performance in an eye tracking task with the faces and performance on an accuracy task, we wondered whether gaze differences could actually explain the age differences in recognition accuracy. We therefore conducted a study in which we tracked subjects' eye movements as they performed the accuracy task. The standard profile of age differences in accuracy was found, and there were also some accompanying age differences in gaze patterns. However, controlling for the gaze patterns did not eliminate the age differences in accuracy, suggesting that the age decrement cannot be attributed to scanning problems alone (Murphy & Isaacowitz, in press).

The evidence reviewed above, in which older adults' difficulties with emotion recognition cannot be explained by gaze patterns, makes this particular domain difficult to connect with SST's view of older adults as motivated to focus on affect regulation. It is possible, however, that motivation in a more general sense can account for older adults' performance. That is, older adults may simply be less motivated than young adults to make the effort for optimal performance on standard emotion recognition tasks, which tend to be low in ecological validity (static pictures of people they do not know). Older adults' looking less at the eyes – and more in the regions of the image "off" the face, as we found in our study – may simply be artifacts of them not caring very much about the task and not being motivated to process the visual material in the most engaged way; this then impairs their ability to perform accurately. We are currently exploring ways to increase older adults' motivation for the task, either through instructions or by making the task more ecologically valid, to determine whether that may ameliorate any of the observed age differences in accuracy.

## SUMMARY: AGING, MOTIVATION AND GAZE

Above, we have reviewed evidence concerning age differences in the visual processing of emotional information. Older adults show positive preferences in their gaze under some circumstances, and this seems to be related to mood-regulatory goals as postulated by SST. However, whether using positive gaze preferences helps older adults to actually regulate their mood and feel better seems to depend on their attentional functioning: older adults who benefit the most from cues also seem to benefit the most from showing positive gaze preferences. Interestingly, whereas positive gaze preferences seem informative in terms of age differences in the regulation of emotion, they do not seem to be helpful in explaining age differences in the recognition of emotion. Motivation in a more general sense, having to do not with specific goals but rather lack of interest in the task, may account for some of the recognition findings.

## WHAT ABOUT CULTURE?

If gaze is indeed motivated, then cultural differences in goals may lead to cultural differences in gaze patterns. Moreover, before focus turned to the positivity effect, SST (Carstensen et al., 1999) originally postulated that the goals we prioritize as we age are emotionally meaningful goals, not necessarily hedonistic goals that lead to greater positivity. In view of this, cultural differences in what is considered to be emotionally meaningful may make individuals from different cultures exhibit different gaze patterns as they grow older.

Self-construal may be a good indicator of what one considers to be emotionally meaningful in a particular context. According to self-construal theory (Markus & Kitayama, 1991), people with an independent self-construal define the self as unique and separate from others, whereas those with an interdependent self-construal define the self as embedded in groups and interconnected with others. Western cultures, such as the North American culture where virtually all the eye tracking studies reviewed above were conducted, are usually found to be more independent and less interdependent than are East Asian cultures (Hofstede, 1980; Markus & Kitayama, 1991; Oyserman, Coon, & Kemmelmeier, 2002; Triandis, 1995). These cultures are more likely to value personal autonomy and uniqueness, whereas the East Asian cultures are more likely to value interpersonal relationships and social harmony.

Such differences tend to intensify with age. Throughout the life-span, individuals from each culture "attune and elaborate" their self-perceptions (Heine, Lehman, Markus, & Kitayama, 1999, p. 767) according to what is "important and useful" in their cultures (John, 1990, p. 67). Fung and Ng (2006) examined age differences in the Big Five personality traits (openness to experience, conscientiousness, agreeableness, extraversion, and neuroticism) and interpersonal relatedness among younger and older Canadians and Hong Kong Chinese. Findings revealed that age differences in the Big Five did not differ across cultures. Yet age differences in some aspects of interpersonal relatedness were found only among Hong Kong Chinese but not Canadians. Specifically, older Hong Kong Chinese endorsed higher levels of *ren qing* (relationship orientation) and lower levels of flexibility (going against norms and traditions) than did their younger counterparts. Canadians did not show these age differences. Fung, Ho, Tam, and Tsai (2008a) further replicated these findings among a large sample of European-Americans and Chinese-Americans, aged 20 to 90 years. Age was found to correlate positively with *ren qing* (relationship orientation) among Chinese-Americans but not European-Americans. To the extent that cross-sectional age differences reflect developmental changes, these findings suggest that with age, Chinese and Chinese-Americans are more likely to adhere to the rule of reciprocity in social relationships and are less likely to go against norms and traditions. Canadians and European-Americans do not seem to show this kind of development.

Similar findings were also obtained in a study on age differences in dispositional optimism among Americans and Hong Kong Chinese (Lu, Wadlinger, Fung, & Isaacowitz, 2007). Prior cross-cultural research has suggested that optimism is closely associated with self-enhancing tendencies that are considered to be more desirable among European-Americans than among East Asians (Chang, 2002; Chang, Sanna, & Yang, 2003). Examining optimism across age, Lu et al. (2007) found that although Americans as a group were more optimistic than were Hong Kong Chinese, this cultural difference was magnified with age. Older Americans were more optimistic than younger Americans; yet Hong Kong older Chinese were less optimistic than younger Chinese. These findings once again suggest that the direction of adult development may be determined by what is considered to be desirable and appropriate in each culture. Americans, living in a culture that regards optimism as desirable, become more optimistic with age. Conversely, Chinese who live in a culture that does not value optimism become less optimistic with age.

These cultural differences even determine how the cultures define well-being. For example, whereas relationship harmony is more predictive than self-esteem of the psychological well-being of Hong Kong Chinese, self-esteem is more predictive than relationship harmony of the psychological well-being of North Americans (Kwan, Bond, & Singelis, 1997). In the aging literature, whereas most American studies (e.g., Bailey & McLaren, 2005) revealed that physical activity enhanced self-esteem among older adults, this association was not found among Chinese older adults (Poon & Fung, 2008). Instead, physical activity, whether defined as housework, exercise, or recreational activities, was found to be positively associated with relatedness satisfaction.

In sum, compared with people from the North American cultures where all the eye-tracking studies reviewed above were conducted, people from East Asian cultures such as the Chinese tend to be more interdependent, more relationship-oriented and less optimistic. These cultural differences increase with age. There has been evidence suggesting that these differences have implications for the types of stimuli that are attention-grasping. Cross-cultural studies have repeatedly found that people from the North American culture, who value personal autonomy and uniqueness (Markus & Kitayama, 1991; Triandis, 1989), may be particularly attuned to positive information (Frey & Stahlberg, 1986), in order to maintain and enhance optimism and self-esteem (Herzog, Franks, Markus, & Holmberg, 1998). In contrast, people from East Asian cultures, who value interpersonal relationships and interdependence (Markus & Kitayama, 1991; Triandis, 1989), may find negative information at least as useful as, if not more useful than, positive information in avoiding mistakes and future social mishaps (Kitayama & Karasawa, 1995). For example, in describing the construct "happiness," Americans describe the positive features only whereas Japanese describe both positive and negative (e.g., social disruption) features (Uchida, 2007). In another study, Markus, Uchida, Omoregie, Townsend, and Kitayama (2006) found that whereas American athletes explained Olympic performance primarily in terms of positive attributes (e.g., my efforts eventually paid off), Japanese athletes did so in terms of both positive and negative attributes (e.g., my family has sacrificed a lot to make my success possible).

This focus on the negative may actually be adaptive for older adults in the Chinese culture. Cheng, Fung, and Chan (2009) argue, using a concept called *discounting*, that projecting a "worse" future may be adaptive when declines and losses are normative, predictable, and at times irreversible in later life. They investigated the effects of discounting on well-being in Hong Kong Chinese adults aged 60 years or older. The participants rated their current and future selves in the physical and the social domains at two time points 12 months apart. Results showed that although future self was positively related to well-being concurrently at Time 1, it predicted lower well-being at Time 2, after controlling for Time-2 physical symptoms and current self. In other words, given the same current self at Time 2, those who had projected a worse future self 12 months ago actually enjoyed better well-being than those who made more optimistic predictions. In another study, Yeung, Fung, and Lang (2008) found among Hong Kong Chinese aged 18 to 91 years that negative social exchanges longitudinally predicted increases in emotional closeness of the social relationships across a 2-year period. This finding is in contrast to the vast American literature on the negative effects of negative social exchanges (e.g., Antonucci, Akiyama, & Lansford, 1998; Rook, 2001). All these findings suggest that unlike the North American culture that places a strong emphasis on optimism and positively valenced information, negatively valenced information and stimuli are important and functional in the Chinese culture.

To the extent that people in East Asian cultures found negative information as useful as positive information, they might either not show the positivity effect or show it to a lesser extent with age. Support for this hypothesis was found by Fung and Tang (2005), who compared memory for positive, negative, and neutral stimuli among younger and older Hong Kong Chinese. In the study, the background music of a government TV announcement on health promotion was varied such that it conveyed positive, negative, or neutral affect. The only difference in recognition memory was found between the negative and neutral versions, with older adults showing better recognition memory for information presented in the negative version of the announcement than that in the neutral version. Younger adults did not show such differences.

To test whether this absence of the positivity effect could also be found in visual attention, Fung et al. (2008c) compared visual attention among younger (aged 18 to 23 years) and older (aged age 60 to 84 years) Hong Kong Chinese, using eye-tracking techniques in the same way and with exactly the same stimuli (facial expressions of different valence), as did Isaacowitz and colleagues (2006a, 2006b). In contrast to the age-related positivity effect often found among Americans, older Hong Kong Chinese generally paid similar levels of attention to positively valenced (happy emotional expression) and negatively valenced stimuli (fearful, angry, and sad emotional expressions) relative to neutral stimuli (neutral emotional expression). Moreover, against this general pattern of "even-handedness," they looked away from happy emotional expression, and fixated more at fearful than at happy emotional expression. Younger Hong Kong Chinese showed no attentional preferences.

This pattern of general evenhandedness is even more apparent in memory. After examining visual attention towards emotional expressions using an eye tracker, Fung, Isaacowitz, and Lu (2008) examined recognition memory towards the same set of stimuli after a 30-min delay. Results showed that younger Hong Kong Chinese remembered happy emotional expression better than all other kinds of emotional expression. Middle-aged Hong Kong Chinese remembered happy emotional expression better than neutral emotional expression, but also fearful more than neutral emotional expressions. Older Hong Kong Chinese remembered happy emotional expression better than neutral emotional expression, but also fearful and angry emotional expressions better than neutral emotional expression. In other words, whereas all three age groups processed positively valenced better than neutral stimuli, a lower level of processing of negatively valenced relative to neutral stimuli was found among younger adults only. Middle-aged and older adults showed increasingly higher levels of cognitive processing of negatively valenced relative to neutral stimuli.

The stimuli for the above studies are synthetic facial expressions that may not have high ecological validity. To test whether the positivity effect would be absent among older Chinese in the face of more real-life stimuli, Fung et al. (in press) examined visual attention towards positive and negative images of aging. In the study, younger (aged 19 to 23 years), middle-aged (aged 42 to 59 years) and older (aged 60 to 78 years) Hong Kong Chinese were presented with a video on aging. The video was made by the Hong Kong government to promote successful aging. One side of the video shows positive images of aging; the other side of the video shows negative images of aging. Fixations towards the two sides of the video were continuously measured by an eye-tracker. To control for the effect of sound on attention, fixations towards the negative side of the video while the image on the positive side was speaking were taken as our measure of attention towards negative stimuli. Replicating the positivity effect found among Americans (Isaacowitz et al., 2006a, 2006b), older Chinese in the study showed less attention toward negative stimuli than did younger Chinese. The attention pattern of middle-aged Chinese was intermediate. However, interdependent self-construal moderated these age differences in attention patterns. Older Chinese only showed less attention towards negative stimuli than did middle-aged and younger participants when they had lower levels of interdependent self-construal. Those who had higher levels of interdependent self-construal showed no age differences in attention.

Taken together, the findings reviewed above suggest that aging is not defined by a specific set of behaviors. In other words, there is *not* a standard way to age. Many patterns of aging, including visual attention, turn out to be malleable, depending on the self-construal, goal, and/or value of the individual.

## CONCLUSIONS AND FUTURE DIRECTIONS

To conclude, we first acknowledge that due to the limited number of studies on the intersection between aging and culture, much of the empirical evidence we have cited is based on cross-sectional studies, conducted in only a small number of cultures. Longitudinal studies on a wider range of cultures are needed to test many of the postulates we have raised above. However, despite the preliminary nature of the evidence we have reviewed, considering it together suggests a promising direction for future research: Aging does differ across cultures, even in basic processes such as visual attention. These cultural differences can be predicted. It may be fruitful to look for cultural differences in aging (i.e., culture by age interactions) in areas where known cultural differences in value (i.e., culture main effects) have already been known to exist.

Future research should examine exactly why and how some aging processes differ by culture, whereas others do not. For example, Park, Nisbett, and Hedden (1999) argue that the relationships between aging and cognition may differ across cultures in predictable ways. Cognitive abilities that are relatively more knowledge-based may show greater cultural differences with age, as individuals acquire more culture-specific knowledge with the passage of time. In contrast, cognitive abilities that rely more on basic cognitive resources may show smaller cultural differences with age. This is the case because basic cognitive resources tend to decline uniformly across cultures when people get older, reducing the possibility for cultural differences in associated functioning. Future studies should explore whether different types of perception may exhibit different age by culture patterns depending on their cognitive demands.

Another future direction will be to further examine whether self-construal and/or personal and cultural value actually moderate age differences in attentional preferences. So far, we have been relying largely on existing findings in the cross-cultural literature to make the assumption that North Americans are more independent and less interdependent than are East Asians (Hofstede, 1980; Markus & Kitayama, 1991; Oyserman et al., 2002; Triandis, 1989). Although this may well be generally true for North Americans and East Asians at the population level, we (with the exception of Fung et al., in press) have not yet directly assessed whether these cultural differences indeed exist among our samples and affect their attentional preferences. Future studies should fill in this gap.

Moreover, should it be the case that gaze is used to serve emotional regulatory purposes, cultural differences in what emotions the individuals value and ideally want to have (i.e., the outcome of emotional regulation) may affect gaze patterns across adulthood. Tsai, Knutson, and Fung (2006) have proposed a model of cultural variation in affect valuation, in which they argue that whereas North Americans value high-arousal positive emotions such as excitement, Chinese value low-arousal positive emotions such as calmness. In view of this, it seems plausible to predict that the two cultural groups may use different strategies, including gaze patterns, to achieve their respective ideal emotions. Studying how affect valuation is related to attentional preferences across culture and age may further our understanding of the exact mechanisms that underlie the interrelationships between gaze and emotion regulation.

Both aging and culture, separately as well as together, provide a framework for understanding how what people want – their goals and trait-level motivation – guides their visual processing. Older adults look differently from younger ones at emotional information, East Asians look differently from Americans at such stimuli, and the age differences appear to vary by culture as well. Studying gaze can be a useful way of delineating specifically what goals are the most relevant to individuals; in other words, gaze is a window onto the different motivations of different groups. To complete the circle in which motivation and gaze help us to understand aging and culture, future work will need to try to create ways of understanding how a perceiver comes to acquire goals as a function of cultural values and developmental changes, and to understand the mechanisms that lead someone's gaze to change over time. Training studies and laboratory-based manipulations of different motivational substrates of age and culture could help us understand how vision does (and does not) vary as a function of time and place.

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# 3

# Cultural Modes of Seeing through Cultural Modes of Being: Cultural Influences on Visual Attention

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We do not see things as they are. We see things as we are. (Proverb)

To the perceiver, the experience of vision feels so effortless, automatic, and instantaneous that most people simply presume they see things as they are, and that the visual system operates like a movie camera, passively capturing all that comes before it. In reality vision is highly constructive, relying on a variety of top-down processes that create meaning from the "blooming and buzzing confusion" of impinging sensory information. Some of these top-down processes are part of our biological endowment or acquired through visual experience in the initial months and years of life (Kellman & Arterberry, 1998). Others may emerge more slowly, and become modified through systematic patterns of social interactions with caregivers and peers. One such process emerging in part through socialization experiences is attention (Chavajay & Rogoff, 1999; Kitayama & Duffy, 2004). Attention is the psychological process that allows perceivers to concentrate selectively on certain aspects of the sensory world, while at the same time excluding other aspects from conscious awareness. Hence, attention is a fundamental cognitive process that determines what visual information is processed. Because cultures vary considerably in socialization practices that foster the development of attention, people in different cultures may acquire different "strategies" of attention early in life. Moreover, these differences in attention strategies may even cause people who live in different cultures to see the same world in different ways.

In this chapter, we elaborate on the alluring possibility that we see things as *we* are, and who we are fundamentally depends on our culture's model of what it means to be a person. Our primary argument is that different cultures foster the development of one of two general modes of being a self. One mode of self, common in many Western cultures, is independently oriented towards achieving personal goals, standing out autonomously from social others, and reasoning analytically. The other mode of self, common in many Eastern cultures, is interdependently oriented towards achieving communal goals, fitting in with social others, and reasoning holistically (Markus & Kitayama, 1991). These two modes of being a self require different strategies of attention that vary in emphasis on focal information or contextual information about objects, individuals, or events. We propose that children acquire these strategies of attention early in life through patterns of culturally mediated social interactions with caregivers and peers. Once acquired, social processes, cultural artifacts, and visual ecologies that are ubiquitous within a cultural world maintain the predominant mode of being and attention strategy, providing affordances for experiencing the self and seeing the world through the lens provided by a culture's strategy of attention.

This chapter will briefly review the history of research on culture and perception, outline our theoretical and conceptual framework, and provide empirical support for our perspective that culture fundamentally shapes not only who we are, but how we see as well.

## A BRIEF HISTORY OF THE TOPIC

In various forms, philosophers have raised questions about cultural influences on visual perception since antiquity (Jahoda, 1993). However, empirical research on the question did not begin until the fields of experimental psychology and psychological anthropology blossomed in the nineteenth century. Around that time, improvements in transportation as well as economic and political conditions led European powers to colonize a large portion of the world. In the process, Europeans encountered hundreds of previously unknown cultures, and anthropologists and psychologists became interested in studying them. At that time, psychologists were primarily interested in psychophysics, the branch of psychology concerning sensory processes and discrimination thresholds. Anthropologists of the late nineteenth and early twentieth centuries were heavily influenced by now-abandoned theories of racial differences in thought processes, but some, such as Franz Boas, Bronislaw Malinowski, and Emile Durkheim, were also interested in the cultural contexts of various societies.

British psychologist W. H. R. Rivers (1901) conducted one of the first experimental studies of cultural differences in visual perception as a member of the Cambridge Expedition to the Torres Straits (New Guinea) in 1896. Rivers tested the sensory acuity of the native people there, theorizing that the minds of individuals living in what were then called "primitive" cultures have greater resources for lower-level psychological processes than those in civilized cultures. Although Rivers found some cultural differences between the islanders and subjects in England, the results were contradictory, and various methodological flaws such as lack of systematic experimental control limit the value of this work (see Titchener, 1916, for an important critique of Rivers' work).

Studies on cultural variations in perception continued through the twentieth century. One direction of research that continues to this day concerns the influence of language on various aspects of visual perception and cognition. Known as the "Sapir-Whorf Hypothesis," after two linguists who investigated the topic, this line of research explores questions such as whether the number of color terms in a society's language influences color perception, or the interaction between spatial and temporal language and space and time perception (e.g., Boroditsky, 2001; Chen, 2007; Kay & Regier, 2007; Roberson, Davies, & Davidoff, 2000). A second line of research concerns the universality of visual illusions and other visual phenomena. For instance, Segal, Campbell, & Herskovits (1966) provided evidence that the Muller-Lyer illusion (in which lines having outward-pointing arrows appear shorter than lines with inward-pointing arrows) is significantly attenuated in societies living in environments that lack 90-degree angles, such as tribes who live in circular huts. Similarly, Annis and Frost (1973) found that the oblique effect (a phenomenon in which tilted lines are more difficult to discriminate than horizontal or vertical lines) is weaker in such non-carpentered cultures. A third set of studies concerned cultural differences in a "cognitive style" that influence visual perception (Berry 1968; Dawson, 1967; Kato, 1965). We will discuss some of this work later in this chapter, as it is relevant to our theory. Finally, other research addressed the universality of Gestalt cues and cultural differences in picture and photograph perception.

Until the 1990s, experimental psychologists interested in perception and cognition conducted the majority of studies on cultural influences on vision. These psychologists were generally more interested in the universality of the visual processes they studied than the cultural – and specifically *social* – processes that might give rise to cultural differences in perception. For instance, although cultural norms may shape preferences for rectangles and squares over rhombuses and circles, there is very little social in the frequency of 90° angles in a culture's physical environment. Similarly, although the linguistic relativity hypothesis argues that color terms influence color perception, there is very little social in the fact that some languages have more color terms than others. Another limitation is that many of the cultures chosen for cross-cultural investigations were sampled for their convenience, rather for their unique cultural qualities. For example, diverse cultures were often lumped together only on the basis of being "agrarian" or "hunter gatherer", although these cultures exhibited almost no other similarities in terms of social structure, history, geography, or socioeconomic status.

Around the early 1980s, a new field known as *cultural psychology* began to emerge that provided a stronger theoretical framework for understanding the influence of culture on a number of psychological processes. The field was pioneered by anthropologists and social psychologists who were interested in social and cultural processes, and who were willing to consider the possibility that social practices fundamentally shape psychological processes. Cultural psychology proposes that culture and mind "make each other up" (Shweder, 1991). Cultural psychology addresses how social practices and processes that are similar or vary among cultures shape not only the contents but also the structure of mind, resulting in a plurality in ways of thinking, acting, and even perceiving. Cultural psychology provides a new theoretical framework for generating testable hypotheses about the social nature of a variety of mental processes, including visual perception.

## INDEPENDENT AND INTERDEPENDENT MODES OF BEING

One of the most fundamental aspects of being human is the experience of having a self (Fiske, Kitayama, Markus, & Nisbett, 1998; Markus & Hamedani, 2007; Mead, 1934). However, the self is not necessarily uniform in kind across different cultures. Rather, the evidence strongly suggests that there are cultural divergences in the self that have important consequences on various psychological processes (Markus & Kitayama, 1991), including attention and ultimately vision.

Our basic theoretical framework appears in Figure 3.1. Our thesis is that cultural traditions, influenced by various historical, social, religious, economic, political, and geographic antecedent conditions, foster a cultural *mode of being* a self (Kitayama, Duffy, & Uchida, 2007; Markus & Kitayama, 2004). A mode of being represents a set of social beliefs, action tendencies, and thought processes that are associated with being a social agent within a given culture. Therefore, our concept of a mode of being is not exactly synonymous with the self-concept, but rather represents culturally sanctioned and normatively practiced models of being a self, which in turn shape internalized self-representations, which include personality traits, cognitive representations, and personal identities.

Although there is considerable variability within and across various cultures, regions and societies, there appear to be two general modes of being a self found in most if not all cultures. The independent mode of being is common in many Western cultures, such as Northern Europe and North America. The interdependent mode of being is common in many Asian cultures, such as China, Korea, and Japan. There appear to be three major characteristic dimensions that

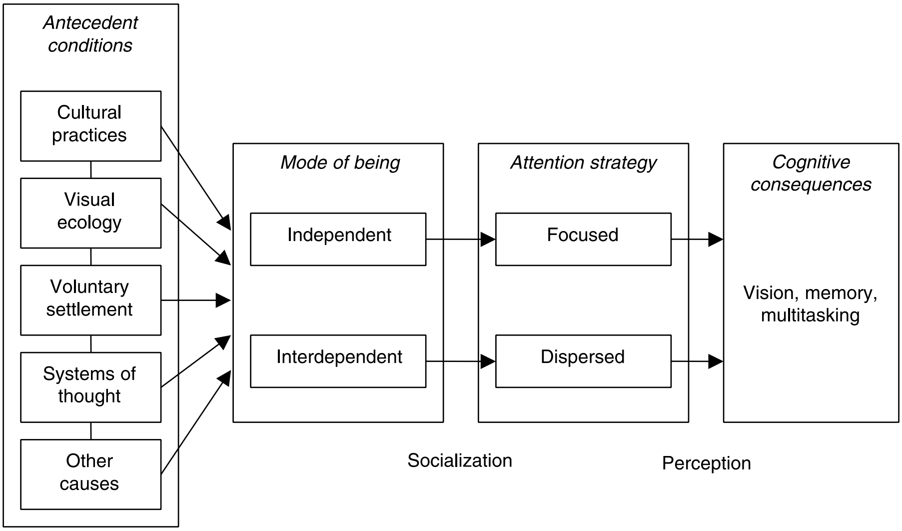

FIGURE 3.1 Theoretical framework.

can describe the independent and interdependent modes of being, presented in Figure 3.2.

One dimension concerns action regulation (Morling & Evered, 2006; Morling, Kitayama, & Miyamoto, 2002; Weisz, Rothbaum, & Blackburn, 1984). In the independent mode of being, the purpose of action is to achieve individual goals by influencing others or changing situations. Independent cultures promote changing the environment using one's own goals, desires, judgments, preferences. They also presume that internal personal attributes form the basis for action. Alternatively, in interdependent cultures, the purpose of action regulation is achieving communal goals by adjusting to social others or accommodating to situations. Responsiveness to concerns of social others, as well as the expectations of others, forms the basis for action.

A second dimension concerns the role of self and social others (Kitayama & Uchida, 2004; Markus & Kitayama, 1991). In independent cultures, the self and individual social others receive emphasis over communal relationships. Selves form the fundamental basis of social interactions, and the majority of social relationships are formed based on mutual agreement. In interdependent cultures, the communal relationships that exist between groups of close family and peers receive emphasis over individual selves. Relationships form the fundamental basis of social interactions, and the majority of social relationships are entered based on the social role of each participant.

A third dimension concerns the characteristic style of cognition (Nisbett, 2003; Nisbett, Peng, Choi, & Norenzayan, 2001). In independent cultures, cognition is analytic, relying heavily on logical or deductive approaches to problem solving. Individual objects, events, or people and their characteristic features form the primary basis for categorization. In interdependent cultures, cognition is holistic, using inferential approaches to problem solving. The similarity between objects, events, or people forms the basis for judgment.

Modes of being originate from an interaction of a variety of identified and unknown antecedent conditions that individuals inherit as part of their embeddedness within a particular cultural world. For instance, one prominent theory is that humans have inherited a rich cognitive legacy of ideas and ways of thinking from the ancient Greek and Chinese philosophy that shape how we think of ourselves

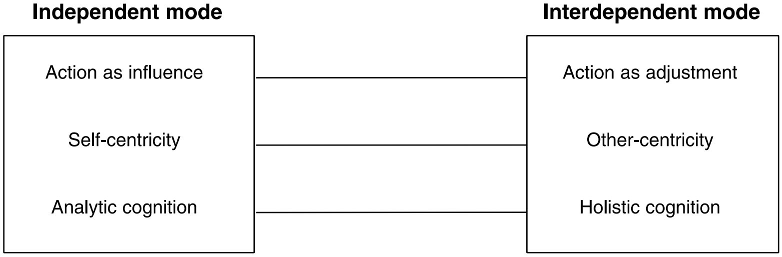

FIGURE 3.2 Dimensions of the independent and interdependent modes of being.

(see Nisbett, 2003; Nisbett et al., 2001). Another is that the independent mode of being is encouraged by patterns of voluntary settlement in frontier territories such as North America, as well as in other frontiers such as Hokkaido, the northern island of Japan (Kitayama & Bowman, in press; Kitayama, Ishii, Imada, Takemura, & Ramaswamy, 2006). Other possible contributing factors include the common form of subsistence within a culture, such as whether herding or farming is a society's predominant mode of food production (Edgerton, 1971; Uskul, Kitayama, & Nisbett, 2007). Other possible explanations concerning ecological conditions, economic activity, and religion have been offered (Kitayama & Cohen, 2007).

It is important to note that not every culture or every individual within a culture exhibits every characteristic of independent or interdependent modes of being. In fact, individuals in every culture contain aspects of both an autonomous and a relational self (Mead, 1934) and in some situations people may exhibit tendencies of one or the other mode of being (Brewer & Gardner, 1996). Moreover, even within a single culture, individuals and groups can vary widely, and many subcultures exist that may act against the normative mode of the culture. Recent studies that have examined such regional (Nisbett & Cohen, 1996) or subgroup differences (Sanchez-Burks, 2002) along different dimensions of cultural experience suggest that modes of being may vary widely within any culture. However, a vast body of work has demonstrated that the independent mode of being is far more common in cultures influenced by European culture, and the interdependent mode of being is far more common in cultures influenced by Asian culture.

Cultural psychologists have studied how the independent and interdependent modes of being influence a wide variety of social processes such as attitude attribution (Morris & Peng, 1994), self-description (Markus, Mullally, & Kitayama, 1997), self-esteem (Heine, Lehman, Markus & Kitayama, 1999), self-perception (Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997), emotion (Uchida & Kitayama, 2001), and self-efficacy (Morling et al., 2002). More recently, cognitive psychologists have begun to realize the importance of cultural modes of being in the dynamic construction of cognitive processes, such as categorization (Choi, Nisbett, & Smith, 1997), reasoning (Peng & Nisbett, 1999), covariation detection (Ji, Peng, & Nisbett, 2000), and object perception (Kitayama, Duffy, Kawamura, & Larsen, 2003). Taken together, the results of this diverse set of studies underscore the importance of the social in understanding basic psychological processes, including visual perception.

## MODES OF BEING AND ATTENTION

Different cognitive competencies are required to negotiate living in a particular cultural world (Kitayama & Duffy, 2004). Some of these skills are readily apparent: to engage in Japanese culture, it is very useful to be able to speak Japanese, use chopsticks, and know when and how to bow to convey respect. To engage in North American culture, it is very useful to speak English, use a fork, and know when and how to shake someone's hand to convey respect. Other cognitive skills required for engaging in a culture are less obvious because they work beneath our own ability to perceive them, and are so pervasive that they affect almost everything we do. We argue that attention is one such "tacit" cultural competence (Kitayama & Duffy, 2004) that varies between societies where the independent and interdependent mode of being is more common.

Attention is a fundamental cognitive process involved in selecting and concentrating on specific aspects of the sensory environment. Over a century ago, William James (1895) identified attention as "the taking possession by the mind in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought . . . It implies withdrawal from some things in order to deal effectively with others" (pp. 403–405). Over a hundred years later, the definition remains relatively unchanged, although our understanding of the processes underlying attention has markedly improved. Attention serves as the gateway of information for all social and non-social cognition. In other words, sensory information that is allocated the resources of attention will be processed and enter consciousness, and become available for making judgments, inferences, or for encoding in memory, thus affecting behavior. Sensory information receiving little or no resources of attention remains out of sight and quite literally, out of mind.

Unfortunately, attention is a mental process that is difficult to observe directly because attention does not necessarily affect observable action in a direct way. Hence, cultural differences in attention can only be inferred by performance on tasks designed specifically to tap into the construct. From a series of studies that will be reviewed later in this chapter, we propose the existence of two attention strategies that vary in breadth or scope of the attentional field (Kitayama & Duffy, 2004). We call these modes of attention "strategic" because they are developed to achieve the specific goal of highlighting and emphasizing those aspects of the visual world most important to being an independent or interdependent self.

In the focused attention strategy, individual objects and their focal features receive the vast majority of the cognitive resources of attention. Objects surrounding an attended object, such as aspects of the object's context, receive little or no attention. In the dispersed attention strategy, individual objects and their surrounding contextual attributes receive relatively equal amounts of attention. Objects surrounding an attended object, or features of the object's context, receive considerable attention, at the cost of focal information about the individual objects. To illustrate focused and dispersed attention, Figure 3.3 presents a symbolic depiction of a typical visual scene where each symbol represents a different object. The lightness or darkness of the symbol represents the amount of attention allocated to each object. With the focused attention strategy, a single object (the circle) receives almost all the resources of attention with little attention allocated to surrounding objects. With the dispersed attention strategy, attention is divided relatively evenly between the circle and the surrounding objects. A metaphor used to describe these two strategies is that focused attention provides a view of the world illuminated by a spotlight, and dispersed attention provides a view of the world illuminated by a floodlight. The spotlight of focused attention provides a narrow beam of bright light that brightly illuminates a single object, and alternatively, the floodlight of dispersed attention provides a wide beam of dimmer light illuminating several objects simultaneously.

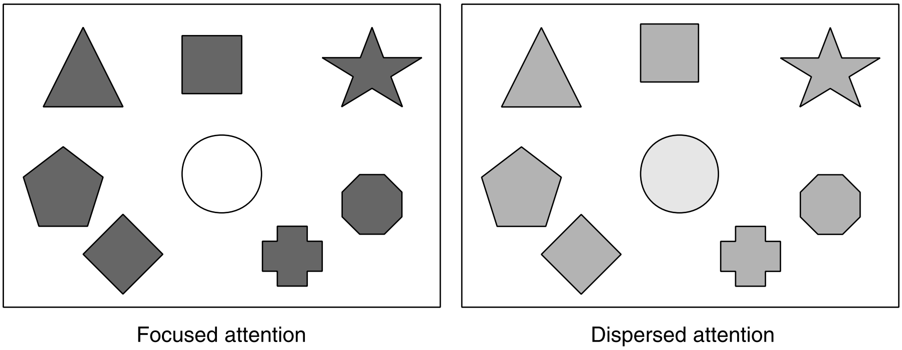

FIGURE 3.3 Focused and dispersed attention strategies.

We propose that the independent mode of being requires competence at focusing attention and the interdependent mode of being requires competence at dispersing attention. Consider why. The independent mode of being presumes a normative model of action regulation in which individual actors influence others, in which individual selves are the fundamental unit of social interactions, and object characteristics and features serve as the basis for categorization and cognition. Each of these tasks requires focusing attention on individual objects, people, or events. Contextual information, whether social or perceptual in nature, plays little role in such processes.

Alternatively, in the interdependent mode of being, the normative model of action regulation is adjustment to various social others, social relationships are the fundamental unit of social interaction, and object similarities form the basis of categorization and cognition. Each of these tasks requires dispersing attention between different objects, people, or events. Focal information, whether social or perceptual, has little role in these processes. Thus, independent and interdependent modes of being provide different social, perceptual, and physical affordances for focused or dispersed attention.

Once again, it is important to note that situations arise in independent and interdependent cultures that require the strategy of attention not characteristic of that mode of being. For example, individuals in characteristically interdependent cultures having dispersed attention must sometimes focus attention on a particular object or task that requires doing so. However, when required to do so, people may be more prone to errors and find such tasks require significantly more effort and control.

## DEVELOPMENTAL ORIGINS OF SOCIALIZED ATTENTION

Although certain attention processes such as orienting toward novel stimuli may be innately available as part of the biological architecture of many species, humans are unique in exhibiting culturally mediated social practices that train attention

(Posner & Rothbart, 2007). Primarily through interactions with caregivers but also with peers and other members of the culture, children acquire experiences that shape and train attention to culturally relevant aspects of the visual environment. Once obtained, social, physical, and environmental affordances of the culture maintain these strategies of attention.

Humans enter the world with a remarkable ability to be shaped, and in turn shape, the sociocultural matrix. However, there are certain temperamental predispositions that babies bring into the world that may have a genetic basis. For example, some babies explore the environment around them, and others are more likely to avoid exploration. These predispositions may have a role in later shaping later personality traits (Caspi, 1998). There are some data suggesting cultural differences in temperamental characteristics between Japanese and North American infants. Bornstein, Azuma, Tamis-LeMonda, and Ogino (1990a) compared the behaviors of North American and Japanese 5-month-old infants. Although there was significant overlap in the behaviors of both parents and infants in both cultures, they found that North American babies explored the environment and vocalized positively (i.e., laugh, giggle) more frequently than the Japanese babies, who tended to vocalize negatively (i.e., cry, whine) more frequently. This suggests a possible temperamental difference between the two groups, which may even have a genetic basis (see Chiao & Ambady, 2007). However, what role these temperamental predispositions might play in shaping cultural modes of being is at present unknown. Additionally, Bornstein et al. tested infants at 5 months; by that point in development, considerable socialization may have already taken place.

Language acquisition is one of the primary developmental tasks of early childhood. Because of this, a significant amount of research addresses cultural differences in language development and specifically in the types of interaction patterns (i.e., joint attention) that are associated with it. To that end, Toda, Fogel, and Kawai (1988) conducted a study in the laboratory in which they videotaped and content-analyzed interactions between mothers and their 3-month-old infants in the United States and Japan. Toda et al. found that US mothers focused more on naming objects, asking questions about objects, and providing information about objects than Japanese mothers. Japanese mothers employed a larger number of emotional vocalizations containing affective warmth but little information, such as coos, greetings, and lulling, than American mothers. This suggests that American mothers, even at an early age, socialize their newborns to attend to object properties and features, and Japanese mothers socialize their newborns to attend to emotions and facial expressions.

Similarly, Bornstein et al. (1990a) investigated how mothers in Japan and North America mediate attention in interactions with their 6-month-old infants at the dyad's home environment. Whereas American mothers tended to encourage their infants to attend to object properties, objects, or events, Japanese mothers encouraged dyadic interactions and employed a greater number of non-verbal vocalizations. Tamis-LeMonda, Bornstein, Cyphers, Toda, & Ogino (1992) followed up on their study with an investigation of North American and Japanese mother–toddler dyads in conversation and play at one year of age. Again, Tamis-LeMonda et al. found that North American mothers labeled and described the properties of objects, individuals, or events far more frequently than did Japanese mothers. Japanese mothers, however, engaged in more pretend styles of play (i.e., pretending to talk into a telephone banana). They found a corresponding difference in toddlers' behavior: North American toddlers had larger vocabulary sizes than the Japanese toddlers, and the Japanese toddlers play contained more instances of other-directed acts and symbolic exchange. Fernald and Morikawa (1993) reported similar findings with a sample of 6-, 12-, and 19-month-old infants, suggesting that this pattern extends into the late infancy period.

As the child develops, various practices encourage the independent mode of being in North America, and interdependent mode of being in Asia, which in turn may foster the development of attention. For instance, Greenfield, Keller, Fuligni, and Maynard (2003) propose that North American parents exhibit a distal parenting style emphasizing physical separation and distance, whereas Asian parents exhibit a proximal parenting style emphasizing closeness and touch. For instance, American babies generally sleep in separate beds from their parents, but East Asian babies almost always co-sleep in the same bed as their parents until early and sometimes even late childhood (Markus & Kitayama, 1991; Shweder, Jensen, & Goldstein, 1995). Carrying devices such as "snugglies" are common in Japan, strollers are extremely rare, while the opposite is the case in the US (Barratt, Negayama, & Minami, 1993). This emphasis on the importance of the interdependent relationship between parents and children can be observed in cultural differences in the number of hours children spend in close proximity to their caregivers. In Japan, infants on average receive 2 hours of non-maternal care per week while in America, infants receive an average of 23 hours of non-maternal caregiving (Barratt et al., 1993). These normative social practices likely give rise to a stronger sense of independence among North Americans and interdependence among Japanese, which in tern require different modes of attending to social and non-social information.

During later childhood and adolescence, Japanese parents promote ideas related to social obligation and expectations and children learn to divide attention among various social others. In contrast, American parents emphasize individuality and encourage children to express their opinions and attempt to change the environment by influencing others. Rothbaum, Pott, Azuma, Miyake, and Weisz (2000) label the Japanese pattern an effort to achieve "symbiotic harmony" and the American pattern an effort to achieve "generative tension." In conflict situations, American parents tend to influence children by disciplining them or enforcing rules, while East Asian parents tend to model restraint by ignoring or acting indifferent to the conflicting situation (Azuma, 1994).

Attention to physical context is emphasized far more among Japanese than North Americans, and this is represented by a greater sensitivity among Japanese to the environment in which a behavior occurs. For instance, there is a sharp distinction in Japan between appropriate behavior within the home (*uchi*) and behavior outside the home (*soto*), such that normative behavior depends on the context in which the person is embedded (Kondo, 1990). This distinction between outside and inside is so strong that most, if not virtually all, Japanese wear separate pairs of shoes when inside or outside their homes. In America, children are taught that behavior is largely independent of context; morality is taught to American children by emphasizing universal rules such as the Ten Commandments that govern behavior independent of circumstance or situational factors (Suzuki, 1973).

The studies cited above suggest that at least in their interactions with children, Japanese and North American caregivers differ in how they mold or shape their children's strategy of attention towards objects and their contexts. The North American caregivers tend to focus their children's attention on the features and properties of objects. Japanese caregivers tend to divide their children's attention between objects, such as a toy, and the mother's facial expression in response to the object. Over the course of many thousands of interactions children have with their caregivers, American children learn to focus attention on object features and properties and Japanese children learn to divide attention between objects and their contexts.

The next section reviews empirical evidence on the cognitive consequences of having been socialized to focus or divide attention.

## EMPIRICAL EVIDENCE FOR CULTURAL DIFFERENCES IN ATTENTION STRATEGIES

At this point, a number of studies provide empirical support for the hypothesized cultural differences in attention. Much of this literature stems from empirical studies of adult populations in North America (mainly the United States, but also Canada) and East Asia (mainly Japan, but also China and Korea). Fortunately, investigations on individuals living in other cultures and at different ages have been increasing in recent years (e.g., Kitayama, Park, Sevincer, Karasawa, & Uskul, 2009; Duffy, Toriyama, Itakura, & Kitayama, in press), adding to our understanding of socialized attention.

### *Visual Attention*

From the 1940s to the 1970s, considerable research was devoted to a construct known in the literature as *cognitive style* or *field dependence/independence*. Pioneered by Herman Witkin and inspired by the Gestalt movement in perception, this literature addressed the facility with which people can differentiate figures from their surrounding grounds. Some people exhibit a field-dependent cognitive style, having trouble disambiguating figures from their surrounding grounds. Others have a field-independent cognitive style, and excel at separating figures from their grounds. In the 1960s and 1970s, cross-cultural investigations of cognitive style found that people in agrarian societies exhibited greater field-dependence than people in urban societies (Berry, 1976) and that participants tested in the United States showed greater field independence than those tested in Japan (Kato, 1965).

Although the cognitive style literature came to view the dimension of field dependence and independence somewhat like a personality variable, a plausible interpretation is that attention strategies mediate cognitive style. Individuals with focused attention (or analytic style of cognition) may exhibit greater skill at perceiving figural information, and those with dispersed attention (or holistic style of cognition) may exhibit greater skill at allocating attention to a figure's surrounding perceptual ground. To determine whether this is the case, Ji et al. (2000) used a task known as the rod-and-frame test to assess whether Asian and North American participants exhibited differences in cognitive style. In this test, participants placed their faces into a translucent tube-like structure. At the end of the tube, participants saw a tilted square frame with a rod in the center. Their task was to align the rod to be parallel with gravity (or perpendicular to the ground), ignoring the tilted frame. It is likely that people having focused attention (North Americans) can more readily ignore the tilted frame, and people with dispersed attention (Asians) experience difficulty ignoring the frame. Consistent with this interpretation, Ji et al. found that Asians showed larger errors in aligning the rod with gravity than the North Americans.

One important limitation of the rod-and-frame task, as well as almost every test developed to measure cognitive style, is that it only measures the extent to which people ignore contextual information (the tilted frame) when the task requires doing so. The test does not measure the extent to which people can include context into judgment when the task explicitly requires doing so. Consequently, the rod-and-frame test does not provide an accurate measure of dispersed attention. In order to measure the dispersed attention strategy, it is necessary to utilize a task that measures how well individuals can divide their attention between an object and its context, which should be easier for those with dispersed attention. Additionally, superior performance is *always* associated with the diagnosis of field independence (as opposed to dependence). Thus, other possible cognitive factors – such as motivation or intelligence – might influence performance. Indeed, this confounding equally applies to all tasks ever used in this literature, thereby calling into question many of the findings of the original studies of cognitive style. For example, field independence is correlated, sometimes quite strongly, with positive personality traits (e.g., Kogan & Block, 1991). Nevertheless, perhaps more conscientious, attentive, and motivated people simply work harder and perform better in these (and for that matter *any* other) cognitive tasks.

Kitayama et al. (2003) developed a task that avoids the limitations of the field independence tasks, providing a measure of both focused and dispersed attention. In their framed line task (FLT), participants are shown a line in a square frame. Participants are then presented with another square frame of the same or different size and asked to draw a line in it. In the absolute task, participants are instructed to draw a line that is identical in absolute length to the original line in the first frame. As in the rod-and-frame task, the absolute task of the FLT requires one to ignore the surrounding frame. Performance in this task, then, should be better for those with focused attention who can ignore the frame, and worse for those with dispersed attention who cannot ignore the frame. The unique feature of the FLT lies in a second task – the relative task – in which participants are instructed to draw a line in the second frame so that it has the same proportion to the new frame as the original line in the original frame. Performance in this task should be worse for those with focused attention, who cannot divide attention between the line and the frame, and better for those with dispersed attention, who can readily incorporate the frame. Together, the two tasks of the FLT measure the attention strategies such that the resulting measure is orthogonal of any third factors such as intelligence and motivation that might be correlated with overall performance.

Using the FLT, Kitayama and colleagues (2003) found that Japanese were more accurate in the relative task than in the absolute task whereas Americans were more accurate in the absolute task than in the relative task. This finding is consistent with the hypothesized attention difference across cultures. Moreover, because the stimuli (lines and squares) are detached from any cultural significance or meanings, any interpretations in terms of culturally specific lay theories or folk understanding would seem untenable.

## *Visual Memory*

A significant proportion of what people remember first enters consciousness through the visual system, thus attention strategies also influence visual memory. Attention may influence what is remembered by affecting what visual information is encoded into memory and what is retrieved from memory. Individuals with the focused attention strategy are more likely to encode and subsequently retrieve information about object features than contextual information. Alternatively, individuals with dispersed attention are more likely to encode and subsequently retrieve information about object contexts than focal information about object properties. Hence, those with focused attention (i.e., North Americans) should be better at remembering individual objects regardless of the context in which the object properties. were presented. However, for those with dispersed attention (i.e., Japanese), memories for individual objects are significantly bound to the context in which they are presented, hence they should remember objects better when presented in the same context in which the object was initially encoded.

Evidence for this predicted cultural difference in memory was provided by a study by Masuda and Nisbett (2001), who showed participants movies of focal fish swimming in a natural context (i.e., aquarium, coral reef). After viewing each film, participants described what they saw. Americans almost always discussed aspects of a primary fish or other moving objects, and Japanese began by discussing background context or other fixed objects. In a second experiment, Masuda and Nisbett explored whether these differences in descriptions extended to recognition memory. In the first part of their experiment, participants simply viewed a series of fish images presented in a natural context. In the second part, their recognition memory was tested with a set of fish from the series as well as novel exemplars not seen before. Importantly, the fish previously seen were presented with no background, the same background, or a different background from their initial encoding. American performance was unaffected by the context manipulation. For Japanese, however, recognition memory was highest when the fish were presented with the original background, and lowest when presented with the novel background. These results suggest that in the first part of the experiment, Americans focused on the features of the individual fish and ignored the background, and Japanese divided attention between the fish and their surrounding context.

However, a possible explanation for Masuda and Nisbett's (2001) finding is that the cultural difference occurred at the time of retrieval rather than at the point of encoding. To determine this, Masuda and Nisbett (2006) used a modified "change blindness" paradigm to determine whether Americans or Japanese exhibit differences in perception that would occur at the time of encoding rather than retrieval. In the study, participants viewed a short movie of a naturalistic scene (i.e., an airplane moving on a tarmac). Immediately afterwards, participants viewed a digitally altered version of the same movie, with both focal information (i.e., airplane's livery) and contextual information (i.e., tarmac's lines) changed. Americans were faster at detecting changes in the focal objects, and Japanese were faster at detecting changes in the background context, which is consistent with the socialized attention hypothesis.

Attention to focal or contextual information about the external visual world is one way that attention influences aspects of a scene people see and ultimately remember; memory itself may serve as an internalized context for making judgments about objects. One such "mnemonic" (i.e., memory-based) context is prior experience with similar objects that are represented as categories or schemas. For example, on encountering a tulip, one might reference previous experiences with tulips that are stored in memory. Those with focused attention might be better able to ignore this mnemonic context and encode focal aspects of objects, and those with a dispersed attention strategy might naturally divide attention between a present object and stored memories of prior instances of the class of stimuli of which the object is a member. Duffy and Kitayama (2007) provided evidence in favor of this possibility. In their task, Japanese and North American participants viewed and subsequently reproduced the length of 192 lines. Over time, people establish a mnemonic context consisting of the lines that they have seen, and begin adjusting responses towards the prototypic or average value of the set. This "central tendency bias" serves as an index of the strength of the mnemonic context. Consistent with the two strategies of attention, Japanese showed a stronger mnemonic context effect than North Americans.

## *Facial Perception*

Recent evidence suggests that differences in attention strategies may influence how people process information about faces. This evidence is particularly striking as many cognitive psychologists have claimed that facial perception is a domain-specific neural process hardwired into the architecture of the brain (McKone, Kanwisher, & Duchaine, 2007).

Miyamoto, Nisbett, and Masuda (2006) examined whether Japanese or North Americans were more likely to engage in featural over configural processing of faces. Prior research has shown that there are two systems implicated in processing information about faces (Maurer, Le Grand, & Mondloch, 2002). Featural processing relies on characteristics of the various features within a face, such as the color of the eyes or the shape of the eyebrow. Configural processing relies on the relation among the various features, such as the relative position of the nose between the eyes and mouth. In their first experiment, North American and East Asian participants viewed a face and then decided which of two composite faces was most similar to the original face. The faces had either featural manipulations (i.e., different eye color) or configural changes (different distance between eyes). North Americans typically rated faces with the same features as more similar than Japanese. In another experiment, participants were tested on accuracy at detecting featural or configural changes in faces. Participants briefly viewed a face, then were shown a second face with either featural or configural changes. Japanese were more accurate than Americans in detecting configural changes as compared to figural changes. This suggests that East Asians were perceiving the face more holistically than the North Americans, who were more likely to attend to facial features.

Along similar lines, a recent study has demonstrated that East Asians and North Americans differ in their processing of the emotional content of faces. Masuda et al. (2008) showed people cartoon images of a target person surrounded by other individuals. The images varied in the emotional congruence between the focal individual and the background individual such that in half the images, the facial expressions were congruent (happy target person/happy background people) and in half the images, the facial expressions were incongruent (happy target person/unhappy background person). The participant's task was to estimate the happiness or sadness of the target individual. For Americans, the facial expressions of individuals in the background did not influence judgments of the happiness of the target individual. However, for Japanese, ratings of the happiness or sadness of the target individual were influenced by the congruence or incongruence of the faces in the background.

### Multitasking

If North Americans exhibit focused attention, and East Asians exhibit dispersed attention, there should be systematic cultural differences in the ability to perform two tasks at the same time, an ability known as multitasking. Consider why. Completing a single task such as using a cell phone requires focused attention towards the task at hand, and the ability to exclude task-irrelevant information. However, in completing multiple tasks at the same time, as is required in preparing a large meal, attention must be divided among the many dishes so that they all are cooked appropriately. The foregoing analysis suggests that Asians may exhibit better performance in dividing attention among various tasks, while North Americans may exhibit better performance in focusing attention on a single task. To test this, Kopecky et al. (under review) asked North American and Japanese participants to perform either one task or two tasks at the same time in a laboratory setting. The tasks involved listening to tones and vocally responding as to whether the tones were high, medium, or low, while watching four figures on a screen and pressing a response box with one of four fingers. There were multiple blocks of training trials in which participants were taught on each of these two tasks individually (single task condition) or at the same time (dual task condition). Participants practiced over the course of two days to try to master the two tasks, so accuracy was very high for all participants. However, Japanese were faster than the North Americans in responding in the dual task condition, which is consistent with the hypothesis that Japanese are better able to divide attention. Both North Americans and East Asians made fewer errors and exhibited higher accuracy on the single tasks, but the effect was stronger for North Americans, suggesting greater facility in focusing attention.

### *Physiological and Neuropsychological Evidence*

So far, the studies reported rely on behavioral measures of accuracy, response time, and subjective ratings as evidence for cultural variations in attention. However, recently, several studies using neuroscience approaches provide evidence for cultural variations in both the way the eye scans the visual world and how the brain processes information.

If North Americans attend to focal information and Asians to contextual information, the two groups might differ in how much time their eyes spend fixated on objects or their contexts. Specifically, the expectation is that North Americans would spend more time looking at objects, and Asians more time at context. To investigate this, Chua, Boland, and Nisbett (2005) showed Japanese and American participants a series of naturalistic images. The participants wore eye-tracking equipment that allowed the researchers to determine the parts of the image people fixated on and for how long. Chua et al. (2005) found that for about the first half-second that participants viewed the image, both Japanese and Americans fixated on the focal object. However, in the second half-second, the North Americans continued to look at the focal object, and Japanese moved onto objects in the background. These results suggest that behaviorally, Japanese and Americans scan visual scenery in different ways.

Because Americans and Japanese attend to focal and contextual information in divergent ways, it is likely that there would be neurological differences in the way the brain processes visual imagery. Gutchess, Welsh, Boduroglu, and Park (2006) studied brain activation patterns while participants looked at visual images using functional magnetic resonance imaging (fMRI). Gutchess et al. (2006) asked participants to rate how pleasant they found images of objects presented in isolation, backgrounds without a focal object, and focal objects combined with backgrounds. Gutchess et al. found that regions known to be important for object processing, such as the left middle temporal gyrus (involved in spatial and facial processing), the angular gyrus (involved in the processing of metaphors), and the right superior/supramarginal and superior parietal gyrus (involved in locating objects in space), showed greater activation in the American than the Japanese sample. Although there were no reliable differences in areas implicated in background processing, the pattern of results suggested a trend towards greater activation among Asians.

More recently, Hedden, Ketay, Aron, Markus, and Gabrieli (2008) studied recently immigrated East Asians and North Americans in a task derived from Kitayama et al.'s (2003) framed line test. Recall in that task that North Americans were more accurate at reproducing the absolute than relative length of a line in a frame, and Japanese were more accurate at reproducing the relative than absolute length. Hedden et al. (2008) found that the tasks activated the same brain regions in Asians and North Americans. However, they found stronger patterns of activation in frontal and parietal areas known to be associated with controlling attention when participants completed the non-culturally preferred task (relative task for North Americans, absolute task for Asians). This suggests that in completing the non-preferred task, participants must work harder and thus exhibit stronger patterns of activation. Additionally, for the absolute task, the amount of activation correlated with self-report measures of independence among the North Americans and Asian enculturation within the Asian sample. These findings provide suggestive neuropsychological evidence for the existence of two cultural strategies of attention.

## CULTURAL DIFFERENCES IN ARTIFACTS AND ECOLOGIES

Psychologists are generally interested in mental processes that exist within the mind (in the case of cognitive psychology) or between individuals (in the case of social psychology). However, humans create objects as well as environments that afford certain behaviors, whether intentionally or not. These objects and environments, which humans inherit from previous generations and that have been shaped by culture, influence the way people think in profound ways. For example, consider housing in North America and Japan. The great expanse of the American continent has afforded considerable spatial separation among individual homes, with large lawns and fences that separate them. In Japan, spatial limitations inherent to a small island nation requires that most houses be built close together, with a majority of the population living in multiple-unit apartment complexes (Duffy, 2009). It is likely that the open structure of the physical environment in North America both reflects and affords independent modes of being, while the enclosed structure of the physical environment in Japan reflects and affords interdependent modes of being. Where one is separated from others, one can focus narrowly on the self, and where one is surrounded by others, one must divide attention more broadly on the others. Although there is not a significant body of work yet on the interaction between modes of being and the structure of the physical world, studies on these issues represent a promising direction for future research.

### *Cultural Differences in Artifacts*

Recently, a Japanese cigarette manufacturer began posting anti-smoking advertisements with warnings such as “A cigarette is carried at the height of a child’s face,” “People who know that picking up cigarette butts is sweaty work don’t litter with cigarette butts,” and “Don’t smoke in a crowd. Coats are expensive.” Each of these advertisements addresses the influence of cigarette smoking on other people rather than the harmful effects of smoking on one's own health. In North America, some recent advertisements include messages such as "You're smart enough to put together an engine. And you're still smoking?" "All my dreams, up in smoke," and "Tobacco use can make you impotent." Each of these advertisements highlights the effect of smoking on an aspect of one's individual self rather than the harm of smoking on other people.

We use this example to illustrate the fact that the independent and interdependent modes of being cause people in different cultures to design cultural artifacts such as advertisements, television shows, children's books, novels, and other objects that afford behavior as an independent or interdependent self, and thus reinforce the strategy of attention common within their culture. For instance, the emphasis of the interdependent self in Japanese anti-smoking ads affords dividing attention between the self and social others, and the emphasis on the independent self in the North American ads affords focusing attention on the self. Continual interactions with such shared cultural artifacts may strengthen and attune attention strategies over the course of time.

Individuals continually interact with cultural artifacts that afford independence and interdependence. A number of studies have explored cultural differences in artifacts between independent and interdependent cultures, such as advertisements (e.g., Belk & Bryce, 1986; Cutler, Erdem, & Javalgi, 1997; Han & Shavitt, 1994), websites (Cho & Cheon, 2005), textbooks (Imada & Kitayama, 2008), children's books (Toriyama, Uchida, Duffy, & Itakura, 2007; Tsai, Louie, Chen, & Uchida, 2007), news interviews (Markus, Uchida, Omoregie, Townsend, & Kitayama, 2006), photographs (Masuda, Gonzalez, Kwan, & Nisbett, in press), and love songs (Rothbaum & Tsang, 1998). In a recent meta-analysis of these findings, Morling and Lamoreaux (in press) examined 40 studies of cultural artifacts, finding that Western (mainly North American) cultural products expressed more individualism than those coming from Asian or other more "collectivistic" cultures. Future research should further elaborate upon the cognitive and perceptual implications of cultural differences in various objects and artifacts that resonate with the independent or interdependent mode of being.

## *Cultural Differences in Visual Ecologies*

On returning from a brief trip to Japan, an American colleague mentioned that she was glad to be back because her "eyes hurt in Japan." When asked to explain, she confessed that all of the signs and neon lights were so busy and noisy that they made her eyes tired. Although our premise is that socialization experiences during the early childhood period initially tune attention, it is reasonable to suspect that the visual ecologies of a culture's environment may afford focused or dispersed attention. Given that humans build objects such as cars, houses, factories, and cities and significantly manipulate the natural environment in various ways, it is likely that people design visual environments that perceptually afford (Gibson, 1979) either focused or dispersed attention. Hence, it may be possible to find evidence for cultural strategies of attention in the artifacts that cultures create, including the visual ecology of objects and spaces (Morling & Lamoreaux, in press).

FIGURE 3.4 Typical Japanese (left) and North American (right) city street.

To provide an example, Figure 3.4 provides images of a typical Japanese (Kamakura) and North American (Philadelphia) city street. The locations were determined by dropping a marker on a map of the respective cities and photographing the street where it landed. In the Japanese image, there are numerous signs, wires, and poles narrowly crowded together. In the American image, there are more open spaces and fewer visual interruptions. Although it is possible to find Japanese street scenes as austere as American ones, and the converse, the typical Japanese visual ecology of everyday life can be described as more "crowded" or "busy" than the typical North American one. Part of this difference, of course, can be accounted for by the fact that North America is simply a much larger land mass than Japan, so there is more room for open spaces. However, an intriguing possibility is that individuals having focused or dispersed attention organize their physical spaces in a way that affords their culture's predominant strategy of attention.

Miyamoto et al. (2006) provided evidence in favor of this possibility in a recent study of the visual ecology of Japanese and North American street scenes. To show that differences exist in the visual ecology of North America and Japan, Miyamoto et al. first obtained images by randomly photographing a large number of scenes in the US and Japan. In their first study, North American and East Asian students rated the images in terms of ambiguity of object boundaries within the scene and the number of objects present in the scene. They found that the Japanese scenes were rated as having more objects with ambiguous boundaries and a larger number of objects than the American scenes. Miyamoto et al. then used a software package that objectively measured and counted the number of bounded objects in each scene. Confirming the subjective ratings, Miyamoto et al. found that the

Japanese scenes contained a larger proportion of unbounded objects than the American scenes.

The key question, however, is whether the visual ecology of Japanese and North American scenery actually affords dispersed or focused attention. Miyamoto et al.'s second study addressed this possibility using a priming manipulation. Japanese and North American participants viewed a series of either Japanese or North American scenes. Afterwards, they were tested using Masuda and Nisbett's (2006) change blindness test. Japanese and North American participants primed with Japanese scenes were more likely to notice changes in the context than participants primed with North American scenery were. This suggests that merely looking at a different culture's physical environment can temporarily shift attention strategies, and thus how one sees the world. Although more evidence is needed to confirm this hypothesis, future studies on the cultural psychology of built and natural environments (e.g., Duffy & Verges, 2008) may provide important insight on the mutual constitution of the mind, the sociocultural environment, and the physical environment.

## CONCLUSION

In his essay "The World of Pure Experience," William James (1912) questioned whether two people can truly see the same world. His answer was that "My experiences and your experiences are 'with' each other in various external ways, but mine pass into mine, and yours pass into yours in a way in which yours and mine never pass into one another" (p. 47). Although two people can view the same visual scene, attention mediates what "passes into" conscious experience. Early in life, people in different cultures learn to attend to the world in divergent ways through systematic patterns of social interactions with caregivers and peers. Once acquired, these cultural strategies of attention ultimately shape how people see, think, and remember information acquired through the visual system.

That culture fundamentally shapes perception and cognition has implications for research and scholarship in many disciplines. For psychology, at least, the insight that culture influences such a basic process as attention may broaden the scope of the field from a narrow focus on universal processes to examining how various social, economic, political, geographic, and environmental factors influence how the mind works. For other social science disciplines such as sociology, history, political science, economics, the notion that people see the world through the lens of culture may help explain certain complex social phenomena. For instance, historians may be interested in questioning whether the individualistic, anti-communist stance of settler governments such as Rhodesia may be related to the independent mode of being fostered by European settlement in the African continent. Economists and sociologists may be interested in how different career paths foster different ways of attending to the information in the world (Sanchez-Burks, 2003).

Understanding cultural differences in basic psychological processes may ultimately help promote cross-cultural communication and exchange. It is possible that disagreements arising between individuals and social groups originate in the fact that people see and understand the world differently. Future research on the cultural psychology of socialized attention may not only help us better understand, but also appreciate, how we see the world as we are, and others see their worlds as they are.

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# 4

# Wishful Seeing: Motivational Influences on Visual Perception of the Physical Environment

EMILY BALCETIS and DAVID DUNNING

Imagine you were witness to the 2007 Champions League first knockout round soccer match played in Italy. As an avid AC Milan fan, you may have convinced yourself you saw that reckless Celtic player, Mark Wilson, cruelly clip your beloved Alberto Gilardino – sending Gilardino into a prolonged and dangerous five-step tumble. Or, perhaps you were a more objective and disinterested witness. Instead, you would have seen it as the acrobatic and well-choreographed feigned fall that it truly was.

Or, switching to a different setting, imagine you are a standup comedian struggling to make a name for yourself. After your new and improved commentary on the latest misadventures of some religious figureheads, a few zoo animals, and a bar, the audience gives such little reaction that you can hear the roaches scamper back into the woodwork. Yet your hope to salvage the joke creates the certainty that the lone figure at the table in the back corner is really laughing at the punch line rather than choking on his olive.

In their everyday life, people generally assume that they see the world around them the way it really is. When camping in Colorado, hikers believe they see the horizon as dotted with snow-covered mountaintops. When laying on the beach in North Carolina, sunbathers believe they see pelicans flying above the breaking waves. And these people would nearly always be right. Indeed, it is difficult to imagine *not* believing that the sights and sounds delivered to conscious awareness by perceptual systems are accurate renderings of the outside world. It would be difficult to know how to act if one could not trust one's senses to accurately report what the world outside is like.

However, no matter how compelling this belief is, a wealth of research in psychology argues otherwise. People rarely see the world with true clarity, accuracy, and completeness. Of course, a great extent of what perceptual systems report is accurate. When we stand in our garage, it is our car that is in front of us. But at the edges, what people see of their world may not reflect what is going on outside in the environment but may instead reflect biases and errors that are internally generated. If there is an ambiguity (e.g., is that a rust spot or a glop of dirt on the front fender?), how perceptual systems resolve that ambiguity might be more related to events internal to the perceiver than to those in the physical environment.

Our research explores biases in visual perception that arise when people confront ambiguous or indistinct stimuli in their environment. We examine how internal psychological states can influence visual experiences and push people to see one version of their environment that is not necessarily the only version possible. In particular, we argue that people harbor motivations that regulate, guide, and shape their visual experiences of the world around them. Like the soccer fans and the desperate comedian described above, people are prone to resolve ambiguity in a way that allows them to see what they want to see.

In this chapter, we provide an overview of the work we have done so far showing that the motivational state of the perceiver has a significant influence on visual perception. In particular, we examine a common and pervasive motivational state – the motivation to think well of the self and to hold an optimistic outlook on one's own possible outcomes. There is a long tradition in psychological research showing that people engage in motivated reasoning when it comes to conscious thoughts. This information processing style biases their analysis and resulting beliefs, leading people to reach pleasant conclusions over threatening ones. This process leads people to believe that they are more competent and moral than their peers, that the world is a benign place, and that their futures shine brighter than do others' (for reviews, see Dunning, 2005; Kunda, 1990). We can also call such motivationally biased reasoning by its more everyday name, *wishful thinking*.

Our mission in the research reported herein has been to ask how "deep" wishful thinking might go. Might it break the barrier of conscious thought and analysis to extend down to psychological processes that are clearly preconscious in nature? Can wishful thinking influence processes that take place before any of the products of wishful thinking reach the threshold of conscious awareness? More specifically, does wishful *thinking* extend down to the preconscious operations that take place in vision? Does the motivation to live in a benign world shape what people literally *see* in the world, molding what the visual perceptual apparatus presents to conscious awareness? In short, does wishful thinking have an accomplice – *wishful seeing* – that resides in perception?

We begin by reflecting on the history of these questions. To be sure, several noted scholars laid the foundation for the investigation of wishful seeing decades prior to our own. Next we discuss recent findings showing that wishful thoughts influence how people interpret stimuli in their physical environments that are visually ambiguous. We then describe some specific mechanisms by which wishful preferences have their influence. Next, we expand our discussion to describe the potential benefits that wishful thinking might provide for the perceiver. We also, however, note some costs, and some instances in which people might do the exact opposite of wishful seeing, perceiving more threat in the world than actually is the case. We end by discussing some limits on the power of wishful seeing.

## HISTORY OF WISHFUL SEEING

Philosophers and scientists alike have questioned the veridicality of perceptual experience throughout the decades. Helmholtz (1867) held that visual information is generally impoverished. Perception, then, requires that the perceiver arrive at a probabilistic interpretation of this poor input, a process that is subject to unconscious inference. Beginning in the early 1900s, many argued that perceptual experiences are the result of more than simply the interaction of the stimulus and the retina. Instead, they articulated, "what is said to be perceived is in fact inferred" (Bartlett, 1932, p. 33). Perception is not the result of cold, calculated processing of light, but is instead the result of concurrent interactions among experienced sensations, memory and thinking, and social influences. For instance, to illustrate the illusion of motion in the sequential presentation of static images, and when proposing the Gestalt principles of perception along with Koffka and Kohler, Wertheimer included higher-order psychological mechanisms outside of direct sensation.

Among the most notorious characters proposing that psychological states are a source of perceptual bias, Freud advanced that drives to control impulses, to distort memories, and to maintain emotional restraint influence perception (1900/1953, 1899/1962; see also Erdelyi, 1990; Gilmore & Edward, 1999). While a cigar might be just a cigar, sometimes it could be seen as something entirely different depending on the perceivers' dynamic, unconscious drives. Knowing when Freudian theory would predict such distorted perceptions, though, was uncertain. As a result the field grew frustrated with Freud's lack of scientific rigor and testable hypotheses.

As the field of empirical psychology developed, so too did the interest in exploring interactions between psychological states and lower-level processes. The most noted and systematic of these pursuits was the New Look approach to perception that crested in the late 1950s (Bruner & Minturn, 1955). The New Look resolved to demonstrate that perceptual experience was subject to influence by complex, higher-order processes, not necessarily available to verbal report or direct observation. One such influence included the value the perceiver placed on objects. For example, Bruner and Goodman (1947) asked children of varying social economic conditions to estimate the size of monetary coins by manipulating the diameter of a beam of light. Children of poorer families, for whom the value of money was greater, overestimated the size of the coins compared to children from more affluent families who presumably considered the coins less valuable. Similarly, adult participants estimated the size of a swastika, coins, and a neutral disc (Bruner & Postman, 1948). After controlling for absolute size, the swastika – the object of most extreme value, however negative – was the most overestimated of the items.

Although met with enthusiasm, the New Look approach encountered withering critiques and disparaging confounds (Eriksen, 1958, 1962; Eriksen & Browne, 1956; Goldiamond, 1958; Prentice, 1958; Wohlwill, 1966). Critics questioned whether psychological states influenced visual perception or conscious responses and memory. For example, it is uncertain whether participants took longer to report offensive words because they simply did not see them or because it took longer to overcome the surprise or unexpectedness of their presence or the embarrassment of saying them (Erdelyi, 1974, 1985). Likewise, highly valued stimuli can be less familiar, and unfamiliarity rather than motivational relevance may have slowed participants' ability to respond (Adkins, 1956; Howes & Solomon, 1950). For instance, children could have overestimated the size of coins not because coins are of higher value to people with less money, but because the coins are less familiar and less accurately remembered (McCurdy, 1956).

Although the growing want for scientific rigor stifled the New Look investigations of perception, interaction between mental states and perception piqued the interest of a small group of neo-Freudians. Proponents of what is now called New Look 2 (Greenwald, 1992) suggested a functional value of biased perception, and advocated for its use as an unconscious defense mechanism (see Erdelyi, 1996, for a review). New Look 2 maintained that psychological states could, at times, promote perceptual defense and, at other times, promote perceptual vigilance. Unfortunately, New Look 2 addressed issues primarily of concern to clinicians, making it difficult for this work to achieve longevity in the broader scope of psychological scholarship.

These issues aside, both New Look perspectives left their mark on contemporary psychology. Although piecemeal, early theories regarding the interaction of psychological states and perception suggested basic postulates that propagated through the following decades. Psychologists uniformly agree with the New Look tenet that much of cognition happens outside a person's awareness or control (Greenwald, 1992; Wegner & Bargh, 1998). Identification, recognition, and categorization are directed by perceivers' previous visual experiences as well as context (Biederman, Mezzanotte, & Rabinowitz, 1982; Boyce & Pollatsek, 1992; Li & Warren, 2004; Long & Toppino, 2004). Likewise, people's conscious experience and understandings of their environment omit much information that the environment actually contains (Allport, 1989). People fail to notice objects in their environment that are clearly present to others (Mack & Rock, 1998) and, at other times, may miss major changes to the visual scene that occur right before their eyes (Simons & Levin, 1998).

In the present day, with the advent of more sophisticated technologies and theories, the time might be ripe to reintroduce the investigation of the questions raised by New Look researchers. With consideration of the groundwork laid by these scientists and their critics, we decided to open our own investigation into the potential impact of motivational biases on visual perception. We ask if people literally see what they want to see. Are their wishes for specific perceptual experiences the result of active goals and need states? In addition, we explore several of the visual mechanisms by which biases in perceptual experience arise.

## DOCUMENTING WISHFUL SEEING

Our research asks whether wishful seeing – that is, the motivation to see the world as a congenial place – influences visual perception. To ask this question, our research follows a general method. First, we manipulate participants' wishes and preferences by creating one desirable perceptual outcome over another one. For instance, we might tell participants that they are taking part in a taste testing experiment, and that they will consume one beverage from two possible options. One of the options is a delicious and enticing glass of freshly squeezed Valencia orange juice. The rather unappealing alternative is a gelatinous, chunky, foul-smelling green slime labeled an "organic veggie smoothie" (Balcetis & Dunning, 2006, Study 1).

We then explain to participants how the specific drink they will consume will be chosen. Participants learn that a computer will present them with an image. If the computer displays a letter of the alphabet, they will drink the orange juice, but if it displays a number, they will drink the veggie smoothie. (For some participants, of course, the pairing is switched.) We presume that this instruction causes letters of the alphabet to be the desired outcome over the appearance of a number. We then present participants with the critical computer image, which just happens to be an ambiguous one, although participants do not seem to notice the ambiguity. For example, we display a line drawing that could be interpreted as either the letter "B" or the number "13" (see Figure 4.1A) for 400 ms. This presentation duration is long enough for participants to reach one perceptual conclusion about the identity of the image but not long enough for them to realize that the drawing could be interpreted in more than one way.

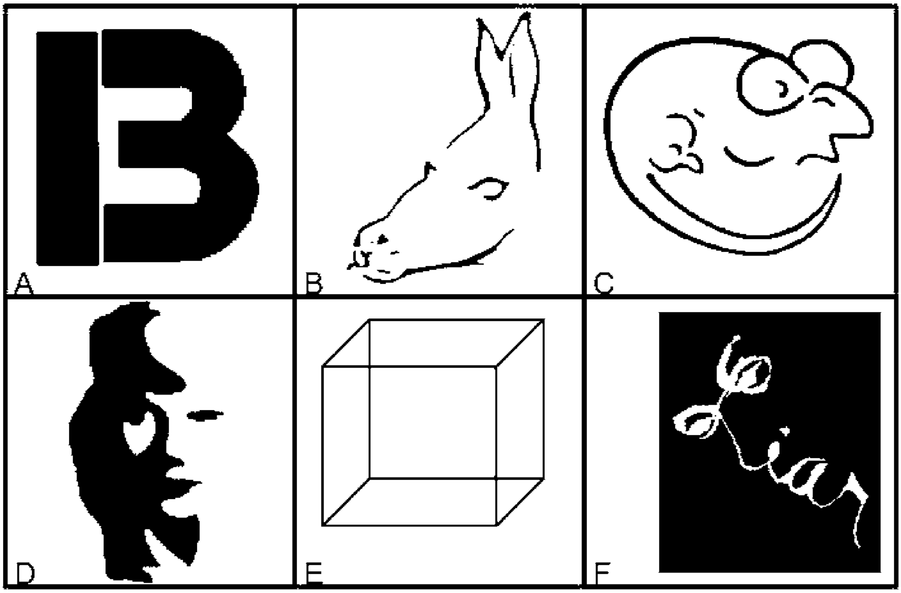

FIGURE 4.1 Ambiguous figures; see text for explanation. (4.1B reproduced with permission from the Psychonomic Society. 4.1C is reproduced from Bugelski & Alampay (1961), copyright 1961, Canadian Psychological Association; permission granted for use of material. 4.1D reproduced with permission from Roger Shepard.)

We then ask participants what they saw. Across many motivational techniques and ambiguous images, we find support for our prediction. Participants are more likely to see the image we presume they want to see over the one they wish to avoid. For example, in our initial experiment in this research program, 72% of participants wanting to see a letter saw the letter B; none saw a number. Of those wishing for a number, 61% reported seeing the number 13 and only 24% reported seeing a letter (see Balcetis & Dunning, 2006, Study 1).

Follow-up studies confirmed that the wish to see one image over the other led participants to honestly see one interpretation of an ambiguous stimulus over another one. We showed that they were not lying about what they saw or just saying what they wanted us to hear. For example, we told participants that they would soon experience an event they might enjoy over one they might not based on whether the computer showed them a farm animal or a sea animal. The exact stimulus they saw is contained in Figure 4.1B, which can be interpreted as either the head of a horse or the body of a seal. People tended to report seeing the interpretation that assigned them to outcomes they wanted. But, importantly, unobtrusive measures of perception revealed that participants tended to honestly see the interpretation they favored. In one study, we measured participants' initial eye movements upon being shown the horse/seal figure. We tested whether participants looked at the verbal label "farm animal" at one side of the computer screen or at "sea animal" at the other side. Initial eye movements are generally not the result of conscious controlled processing (Allopenna, Magnuson & Tanenhaus, 1998; Richardson & Spivey, 2000; Tanenhaus, Spivey-Knowlton, Eberhard & Sedivy, 1995). More often than not, participants' eyes flicked to the label for the type of animal they wanted to see, which a vast majority of the time was also the animal they consciously reported (Balcetis & Dunning, 2006, Study 3).

But a final study conclusively showed that biases in preferences led to honest biases in the perception of ambiguous stimuli. In that study, participants saw the horse/seal figure, and knew that what they saw would determine whether they drank tasty orange juice or the noxious garden smoothie. Some were told that being presented a farm animal would win them the orange juice and a sea creature the smoothie, whereas other participants were told the reverse. The figure was shown for one second, and then disappeared. A computer error message then appeared. The experimenter expressed surprise, and commented that the computer removed the image because of an error in the instructions given to participants. The experimenter went on to say he or she was wrong about which animal was linked to which outcome. Those told initially, for example, that farm animals were linked to orange juice were now told that sea creatures were supposed to be linked to the more desirable outcome. Participants then reported what they had seen. The key question was whether participants would report seeing the interpretation of the ambiguous figure that was preferred at the time they actually viewed the stimulus or the opposite interpretation that was now favored after switching the meaning of seeing farm and sea animals. In general, participants reported seeing the interpretation they favored as they viewed the stimulus, even though that report now assigned them to the undesired experience.

Beyond wishing for a specific perceptual experience so that one can enjoy a preferred beverage, social variables can predict biases in perception that align with other wishes. Other research in our labs suggests that perception may occur in the service of sustaining a positive view of the self. Participants received negative feedback regarding their physical health, information that was contradictory and threatening to their sense of self. These participants, who were hoping to distance themselves from such bad news, estimated that the computer monitor displaying that information was further away from them than participants who received positive feedback that confirmed their self-views or participants for whom the numbers were meaningless (Cole & Balcetis, 2008).

Likewise, the wish to think well of oneself can bias the ways people literally view themselves, leading to permanently distorted perceptions of one's own physical features (Epley & Whitchurch, 2008). Photographs of participants' faces were morphed with more or less attractive standards. Participants were more likely to select as their true likeness an attractively enhanced version of their own face out of a lineup – a tendency that was not present when identifying the face of a stranger. This tendency was positively related to participants' own implicit measures of self-worth. In addition, the speed with which participants made such identifications suggests that this effect is not the result of conscious comparison processes but the result of a genuine belief about their own levels of attractiveness.

## POTENTIAL MECHANISMS UNDERLYING WISHFUL SEEING

Although we have completed several demonstrations that one's wishes, preferences, and desires can influence how people interpret visually ambiguous stimuli, we are only now beginning work to specify the exact perceptual mechanisms that underlie the impact of wishes on visual perception. However, given past work in visual perception, both inside and outside our labs, we can safely speculate on mechanisms that are likely to underlie the link between motivation and perception.

### *Pre-sets and Filtered Perception*

The naive assumption among many laypeople is that the eye functions like a camera, in that the visual system captures everything in the environment in all its detail. This assumption of comprehensive vision can lead car drivers to assume a false sense of security, relying on the notion that they see what is out there by merely opening their eyes and looking. Regardless of their delayed reactions (Strayer & Johnston, 2001), accident record (Svenson, 1981), or that they were just pulled over for speeding (Blincoe, Jones, Sauerzapf, & Haynes, 2006), most people see their driving performances as more cautious and skilled than most others'.

However, the assumption of comprehensive vision is wrong. Not all the features and details of a physical stimulus are contained in the representation of the surrounding environment that reaches conscious awareness. The capacity of people's attention is just too limited. If attentional capacity is pushed, as is the case when the driver of a car decides to take a cell phone call, performance suffers. A 20-year-old driver who takes a call reacts with the same speed as a 70-year-old driver not using a phone. Drivers on cell phones react to brake lights 18% slower and take 17% longer to regain their original speed. In fact, chatty motorists perform worse in driving simulations than drunken drivers with blood alcohol levels exceeding 0.08 (Strayer & Johnston, 2001). Even when cell phones are not implicated, one predominant cause for driving errors is the simple fact that perceivers have a finite attentional capacity that must be distributed among many forms of sensory information. Not all features of the environment – even important ones – reach conscious awareness in a way that can guide behavior.

Perceivers cannot process all the sights and sounds that overwhelm the senses at any given moment. To avoid drowning in a flood of information, perception is necessarily filtered through a finite attentional lens – choosing what in the environment to pay attention to most closely. We suggest that psychological and motivational states can guide these attentional filters, thereby biasing perception very early on – even before a given stimulus is presented to view. These filters sift perceptual information to shape perceptual experiences, sort the incoming stream of information, and assist in categorization and identification.

### *Evidence for Perceptual and Conceptual Filters*

Filters are born from many types of information or experiences including expectations, past experiences, underlying assumptions, beliefs, and attitudes. Although there are many experiences that can create them, filters generally assume one of two types. The first type is the *perceptual* filter, and the second is a *conceptual* filter (for a discussion, see Balcetis & Dale, 2007). A *perceptual filter* involves specific, directly relevant labeling information immediately descriptive of upcoming visual stimuli. For example, participants in experiments who just viewed pictures of animals were more likely to see the famous rat/man ambiguous figure as a rat, while those who viewed pictures of human faces saw it as the face of a man (see Figure 4.1C) (Bugelski & Alampay, 1961; Crandall & de Lissovoy, 1977). Seeing animals, versus humans, activates a number of physical, local features associated with animals (e.g., four legs, tails, fur), thus making them more cognitively available and increasingly capable of capturing attention. These features can be detected because the filter separates these features from others.

The second type of filter is a *conceptual filter*. Unlike perceptual filters, conceptual filters do not contain information that is physically descriptive of an upcoming visual experience. Instead, conceptual filters suggest a visual experience without directly describing it. For example, consider a study in which participants read one of two stories. One was a set of arguments about the legality of the music file sharing service, Napster. The other focused on the legality of pornography and its implications for basic human and constitutional rights. Immediately after, participants completed a second, ostensibly unrelated task where they had to identify an image after a brief 1500 ms exposure. The image was the sax player/face ambiguous figure (see Figure 4.1D).

Note that the arguments people read never mentioned anything that would be physically descriptive of the upcoming stimulus. That is, no musicians (i.e., Kenny G, saxophonists), people (i.e., Hillary Clinton, women), or gender identifications (i.e., female) were mentioned. Thus, there was no direct linguistic label for the upcoming visual stimulus. Instead, only abstract conceptual information had been activated on what was putatively a completely separate task. Nonetheless, of participants who read about Napster, 23% identified the ambiguous figure as a saxophone player, whereas none of the participants who read about pornography identified the figure as such. Those who read about pornography, in contrast, were more likely to interpret this figure as the profile of a woman's face (Balcetis & Dale, 2003).

The activation of conceptual information can be less direct yet still bias visual interpretation of stimulus ambiguity. Conceptual information, for example, can include one's imagined spatial location in the world. For instance, participants in one study imagined one of three scenes. One group imagined looking down the Grand Canyon, another up a tall skyscraper, and a third imagined looking straight out across the Great Plains. Of those who imagined looking down the Grand Canyon, 81% subsequently interpreted a Necker cube (see Figure 4.1E) as one they were looking down upon, while only 44% of those who imagined looking up the skyscraper interpreted it as such. In the control condition that imaged looking straight out across the Great Plains, 68% saw it as a cube they were looking down upon (Balcetis & Dale, 2007).

Importantly, goals can also serve to establish conceptual filters. Participants who had the active goal to detect deception in a conversation between two people, rather than to detect examples of the people flirting with one another, were more likely to interpret the subsequently presented figure as the word "liar" written in cursive rather than the outline of a man's face (see Figure 4.1F). In fact, 75% of participants who were trying to detect deception interpreted this figure as the word "liar" while only 13% of those who were detecting flirting identified it as such (Balcetis & Dale, 2003). Across these studies, the evidence suggests that desires activated a conceptual set associated with the desired outcome even before perceptual systems were exposed to the target object.

## *Wishes and Preferences as Conceptual Sets*

We propose that preferences, wishes, and desires – that is, what a person is motivated to see – can establish conceptual filters through which visual information is sifted. Indeed, empirical evidence from our lab already provides initial evidence that this might be the case. In one study, we used our basic paradigm to make participants wish to see a farm animal rather than a sea creature, or the reverse. Participants who were hoping to see farm animals were more likely to see the horse/seal ambiguous figure as the head of a horse rather than as the body of a seal, replicating our previous results (see Figure 4.1B; Balcetis & Dunning, 2006, Study 4). Importantly, participants in this study were not given specific hints (i.e., snout, tail, fin, flipper) about the physical characteristics of the upcoming stimulus. Instead, only broad categories were activated (e.g., farm animal, sea creature). These categories included a set of features that is much too large to enact a specific feature search strategy, making it unlikely that participants could have scanned the ambiguous drawing specifically to locate features that would allow for a particular interpretation.

Indeed, evidence suggests that the general concepts and broad categories of *farm animal* or *sea creature* had been activated before participants viewed the stimulus, based on their responses to a lexical decision task. In such a task, participants are shown a letter string and asked if it forms an English word (e.g., *barnyard*) or not (e.g., *minslov*). When participants completed this task just before they viewed the ambiguous figure, they were quicker to identify words associated with the desired outcome than words associated with the undesirable one (Balcetis & Dunning, 2006, Study 4). That is, when wishing to see farm animals but before seeing the ambiguous figure that decided the enjoyableness of their next task, participants responded faster to the word *cowboy* than to the word *ocean*.

### *Distinguishing Perceptual and Conceptual Sets*

One important note is that the distinction between perceptual and conceptual set should, perhaps, be appreciated for its descriptive ability rather than its truthful representation of the organization of mental contents. Although we described perceptual and conceptual sets as distinct and separable forms of filters, it is most probable that both types of information play an active, equal, and simultaneous role in filtering incoming information. One type of set will activate the other in an interactive manner.

In addition, the term "set" may suggest that the contents of a filter are discrete – some concepts definitively excluded while others definitively included. However, it might be more accurate to describe both perceptual and conceptual filters as members of "fuzzy sets" where membership is considered gradual and probabilistic. Rather than positing that discrete symbols are, in a binary sense, either members or not, fuzzy sets allow for graded inclusion of membership status. For instance, fuzzy sets give greater weight to the concept of *horse* than to the concept of *ostrich* in the category *farm animals*. Similarly, they give greater weight to the physical features of fish than penguins in the category of *sea creatures*. In this way, both perceptual and conceptual information can be activated to varying degrees within the same distributed representation.

### *Directed Attention Once the Stimulus is Detected*

Wishful seeing may exploit another mechanism once a person is immersed in a complex, saturated, and rich environment. Motivations may infiltrate perceptual processing by directing attention to certain elements of the environment at the expense of others once those elements have been recognized. When New York Yankees pitcher Randy Johnson steps up to the mound, Red Sox fans shout, wave, and toss props about with the hopes of leading his pitches astray, yet they rarely accomplish their goal. Instead, Johnson seems able to focus his attention solely on the batter and the catcher, and seemingly blinding himself to the distractions that surround them.

How does Randy Johnson's visual system parse the busy visual backdrop to focus on the catcher's glove when pitching at Boston's Fenway Park against the Red Sox? After an initial scan of the surroundings, attention is directed to certain elements of the environment at the expense of others – a process called *selective attention* (see Yantis, 1996). This selection is often described as a spotlight that highlights a definite region (Posner & Petersen, 1990), like the Yankee catcher's glove. Such highlighting facilitates perceptual processing at the expense of information in other locations, like the enthusiastic Red Sox fans behind home plate.

Motivations may assist in this process of directing attention to certain objects in the environment once they are detected. For instance, the motivation to satisfy one's thirst arises because one is thirsty, and thirst can exert an influence on perception leading the system to attend to objects that can reduce the need (Aarts, Dijksterhuis, & de Vries, 2001).

There are several ways in which the impact of motivational state on attentional deployment can be assessed. One way we demonstrated this was to measure perceivers' ability to later recognize other objects that were located in a room. To create and direct an attentional spotlight, we instilled in participants a rather pressing motivation. For instance, we made participants thirsty by having them eat a large serving of dry salty pretzels. Thirsty participants were more likely to later recall objects strewn about in our laboratory that were descriptive of their feelings of thirst and objects that were relevant to satisfying their thirst. Thirsty participants, relative to a control group, were more likely to recall the cactus sitting on the shelf and the picture of a cracked desert landscape. In addition they were also more likely to recall having seen a Nalgene water bottle and a bottle of Gatorade. In other words, the activated visceral need state directed thirsty participants' visual attention to objects that were related to their current visceral state of deprivation and to objects related to the goal of satisfying their thirst (Balcetis & Ferguson, 2009).

In other studies, we used another measure to assess the influence of motivational states on attention. Motivational states can influence just how widely or narrowly people adjust their attentional spotlight around some object. It is clear that people can focus their attention narrowly or let it roam widely depending on the specific goals they have in a particular moment. For example, when driving a car, attention needs to be directed to as much of the visual field as possible to guard against obstacles on all sides of the car. However, when trying to find a friend at an outdoor concert, it would be helpful to narrowly focus attention on likely locations, so that resources can be allocated to processing the faces, the voices, and other distinguishing features of people in those locations. In other words, processing resources can either be focused on a small region, allowing fast and precise processing in this restricted region, or distributed over a large region, allowing the processing of multiple stimuli in a less efficient manner.

There are certain objects in the environment that are likely to capture and hold attention – to adjust the spotlight of attention narrowly onto the object – at the expense of other objects in the environment. Witnesses to a crime tend to remember details about what a weapon looked like and maintain poorer memory for the perpetrator's face or clothing (Loftus, Loftus, & Messo, 1987).

Recently, neurophysiologists have used functional magnetic resonance imagery (fMRI) to demonstrate that the attentional spotlight can be narrowly focused or expansively opened to take in much more of the environment. To do this, they measure the blood oxygenation level dependent (BOLD) signal, which represents changes in the concentration of deoxygenated hemoglobin. BOLD signals correlate with changes in blood flow, observable electrical activity, and population synaptic activity. When measuring the BOLD signal using fMRI, Mueller, Bartelt, Donner, Villringer, and Brandt (2003) observed that across V1, V2, primary visual cortex, and V4, the amount of activated visual cortical surface increased when attention was expansively focused over a large region. Importantly, by measuring the percent signal change in the BOLD signal within all four visual cortical areas, they were able to argue that as attention increased in span, fewer processing resources were allocated per square unit of visual cortex. In other words, attention span was represented in the breadth and depth of processing in the visual cortex.

We have found that motivational states can influence the size of the attentional spotlight people throw onto the world. In particular, if an individual sees an object in the environment that would satisfy a goal (e.g., thirst), their attentional spotlight can become narrowly fixed on it. For example, in one experiment (Balcetis, 2006), participants sat across from a target object. For these two groups of people, the target object in question was a full bottle of water. The bottle of water was surrounded by a number of objects located on the wall behind, such as a Far Side cartoon, a silver doily, and a bumper sticker. Some participants ate a large serving of hard, salty pretzels to induce a strong feeling of thirst. Others drank four 8-ounce glasses of water to create a feeling of being quenched. A third group of participants did not consume any food or drink and sat across from a neutral object (e.g., a can opener) irrelevant to satisfying thirst. The purpose of this condition was to have a group of participants for whom thirst was not manipulated or made salient.

After they spent some time in this staged environment, we investigated participants' memory of the objects behind the target object. If perceivers narrowly focused their attention on the target object, they should demonstrate less accurate recognition of objects that were located further from the target object when asked to identify targets and foils later. However, if perceivers had a more expansive focus of attention, they should maintain relatively better memory for those objects on the wall that were located further from the target object. As expected, thirsty participants experienced a memory advantage for objects located closer to the target object. Specifically, thirsty participants had better memory for objects on the wall that were closer to the full water bottle relative to objects on the wall that were further away from the water bottle. Additionally, this difference was greatest for thirsty participants in comparison to control and quenched participants.

Appetizing treats that participants wish to consume, like delicious chocolate cake can capture attention, while a Bundt pan in which the cake was baked that assumes the same physical shape and coloring does not (Balcetis, 2007). We surreptitiously recorded participants' eye movements when they were in the presence of the cake or cake pan. A hidden video camera embedded within the monitor recorded participants' eye movements without their awareness. Research assistants later coded participants' eye movements during the time they should have been completing a marketing survey. In particular, they coded for eye movements that went down to the object and eye movements that went around the environment. Given that participants did not know their eye movements were being recorded, looks to the monitor and the target object are representative of participants' relative focus of attention on the target object without concern for conscious, calculated reporting bias. As predicted, participants were 1.2 times more likely to look at the cake than the cake pan, but participants were 1.2 times more likely to look around the room when in the presence of the cake pan compared to when in the presence of the actual chocolate cake. This suggests that participants' attention was more focused on the delicious chocolate cake rather than the less appetizing baking pan.

As further evidence, we asked if attention, narrowed in response to a desirable object, would carry over into other tasks (Balcetis, 2009). In one such experiment, we had participants eat a large serving of dry, salty pretzels to make them thirsty. Half of the participants ate these pretzels while seated across from a full bottle of water, just out of reach, and half sat across from an empty water bottle.

We then assessed whether the experience had induced more of a global or narrow style of visual information processing. To test processing style, we exposed participants to a black and white drawing of two children carving a pumpkin. Embedded within this drawing were four smaller elements (i.e., a butterfly, jar, tack) that participants needed to search out and circle. We measured the length of time it took participants to find each of these four smaller elements that were embedded in the larger drawing as a measure of local processing. Faster completion times indicated facilitated local processing. After this, the drawing was removed and participants had to complete a recall memory test where they needed to describe the larger elements of the drawing. We scored each memory test for the number of large items they listed (i.e., two children in a living room carving pumpkins) as a measure of global processing. We found that participants who ate the pretzels while seated across from the full water bottle found the four smaller elements 1.4 times faster and remembered 10% fewer global elements of the drawing than participants who ate pretzels while seated across from the empty water bottle. This suggests that the motivational state of thirst coupled with the presence of a goal-relevant object, such as a full bottle of water, facilitated local processing and inhibited global processing (Balcetis, unpublished data).

### *The Consequences of Narrowed Visual Attention*

In addition to measuring visual attention, in other studies we have manipulated the focus of attention. We manipulated participants' visual attention by inducing them to adopt a narrow or expansive span of attention (Balcetis, 2006). Then we explored the consequences of this attentional manipulation on perceptions of distance to a desirable object. All participants sat across from a toaster oven that was baking chocolate chip cookies. Participants randomly assigned to the focused condition were asked to look at the cookies often so as to remind themselves of the sights and smells of the cookies while completing the marketing survey. Participants randomly assigned to the expanded attention condition were asked to look up from their marketing survey often to take in their surroundings. In the survey, participants estimated the distance between them and the oven baking cookies right in front of them across the table. Participants in the focused condition estimated that the oven was 17% closer than those in the expansive attention condition.

This last study suggests that the narrowed attention that participants deployed to desired objects led those objects to be seen as closer, and in several studies that is what we have found. Participants saw a $100 bill that they could win as closer to them than one they could not. When throwing a beanbag at a $25 gift card that they could win, participants tended to under-throw by 6%, but when throwing a beanbag at a gift card worth nothing, they were accurate as the beanbag generally landed on the card, suggesting that participants saw the more desirable gift card as closer, which led them to under-throw the bag (McWhirter & Balcetis, 2008).

In short, narrowed attention induced as a function of motivationally relevant and desirable objects once again leaves people to experience a world that is perceptually biased in a favorable way.

### *Extent of Information Processing*

Wishful seeing can have an impact via a third perceptual mechanism. Motivations may shape the amount of perceptual processing that favored and disfavored elements in the environment receive. This influence can be revealed in two different ways. First, favored aspects of the stimulus may receive more attention and perceptual processing, while disfavored aspects of the stimulus may receive relatively little or no processing. For example, a floundering comedian, trying to gauge the audience's reaction, may spend a good deal of time processing the faces of any audience member who looks like he or she might be smiling but spend little effort processing the faces of audience members who might be frowning. Thus, in the end the comedian might believe that the audience is more favorably disposed to his performance than is the case. While the comedian may rightly interpret the few smiling faces as audience members who enjoyed the performance, this biased sampling tendency lends itself to the erroneous conclusion that the show was a smashing success.

Second, motivations may shape the thresholds or criteria perceivers establish for recognition to occur. In other words, motivation may influence when people believe they have done enough processing and a perceptual conclusion has been reached. The comedian might need just a little hint of upturned lips to conclude that an audience member is smiling, but might require that the lips be contorted downward quite a bit, the nose scrunched, and the eyes narrowed before concluding that an audience member is unhappy.

Recent evidence has shown that motivations influence perceptual processing by both impacting the amount of attention favorable and unfavorable stimuli receive and the criterion established for perceptual conclusions to be reached. Voss, Rothermund, and Brandtstädter (2008) showed participants color patches on a computer screen. The patches contained a mixture of pixels of two colors, such as blue or orange, arranged in a random pattern. Participants looked at a patch and decided which color constituted a majority of the pixels. However, the experimenter occasionally mentioned that participants would receive a small monetary reward if a majority of pixels were one color rather than the other. At other times, they were told that money would be taken away from them instead. Not surprisingly, this influenced the judgments that participants reached about which color was the predominant one. More often than not, participants stated that the favored color was more predominant in the patch than the disfavored color – even when that was not actually the case. Furthermore, they reached these favorable conclusions more quickly than they did unfavorable ones. In other words, participants erred in the direction of wishful seeing, and reached favorable conclusions, whether right or wrong, with greater speed than unfavorable ones.

Additionally, Voss and colleagues analyzed the specific processes that led to this pattern of biased perception. From their microanalysis of speed and error, Voss and colleagues (2008) concluded that the motivation instilled by monetary rewards influenced perceptual processing in two ways. First, participants spent more effort gathering information suggesting their favored conclusions. That is, participants more eagerly searched for pixels containing the favored color over pixels containing the unfriendly color – thus indicating more perceptual processing of favored aspects of the environment. Second, participants appeared to have an earlier informational "cut-off" when reaching favored conclusions. That is, they ended their search sooner when the collection of pixels suggested a favorable conclusion rather than an unfavorable one. They did not need to scrutinize the color patch for long periods of time if they suspected that the predominant color of the patch was in their favor.

## THE FUNCTIONAL VALUE OF WISHFUL SEEING – AND VIGILANT MONITORING

Taken together, the research described above suggests that wishful thinking biases people towards seeing the good in their environment and away from seeing the bad. And, in a sense, the conclusion that good looms larger than bad in the environment seems like an intuitive conclusion to reach.

However, there is one problem with it. The opposite intuition seems equally plausible. Bad can loom larger than good. And people may find themselves gravitating towards vigilantly monitoring the environment for harm and threat. Psychological research yields evidence for this hypothesis. Baumeister and colleagues (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001) put forth a treatise emphatically stating that bad is stronger than good. They flooded their readers with countless examples, discussed much research, and offered theoretical rationales that negative information and events loom larger than the positive. Bad parents, bad emotions, bad life experiences, bad relationships, and bad feedback, among many other examples of negativity, all impact life in more extreme ways than their positive counterparts. It might seem, then, that most of the work described in this chapter stands in stark contrast to this well-supported assertion that "bad is stronger than good."

How can we reconcile these two seemingly plausible yet contradictory statements regarding the attractive power of good versus bad? A closer look at the *functional value* of both perspectives provides a useful and informative way of resolving this contradiction. To explore functional value, we consider how a perceptual bias assists the perceiver in accomplishing active goals. In some contexts, looking for the good adds functional value for the perceiver. However, in other contexts, being vigilant toward the bad may provide functional value.

### *Dispelling Distress*

In many cases, negative experiences can hurt a person more than good experiences can help (Baumeister et al., 2001). For instance, a bad day can snowball into a bad week, but a good day rarely does anything to change the hedonic forecast for the day after (Sheldon, Ryan, & Reis, 1996). Distress early in marriages predicts later divorce, but love and affectionate communication does not (Huston, Caughlin, Houts, Smith, & George, 2001). Social rejection hurts self-esteem more than social acceptance helps it (Leary, Tambor, Terdal, & Downs, 1995).

Because negative social experiences can impact the psychological self in such strong ways, it is important to have a means to combat, protect against, or repair the self when confronted with such experiences. We argue that people need a system biased towards wishful seeing which can serve as a defense against the bad that they confront on a day-to-day basis. One might consider our experiments as examples of daily stress or a hassle. In order to cope with the stress we induced, participants may have engaged in wishful seeing. If the next 30 minutes or so in the lab could be fun or could be unpleasant yet one has no voice in making the decision about what the future holds, it might be functionally valuable to see the good rather than the bad. Indeed, setting oneself up to see the worst could further increase stress.

### *Dispelling Dissonance*

We explored how motivationally biased perceptions might be employed to rid the perceiver of negative affect (Balcetis & Dunning, 2007). Negative affect arises as a result of many daily experiences, and one particularly powerful inducer of negative affect is holding contradictory beliefs. A long tradition within personality and social psychology has shown how people manipulate and regulate their beliefs in order to maintain a coherent and harmonious view of the world. People abhor holding beliefs that contradict one another, in part because such contradictions produce feelings of mental turmoil, psychological unrest, or cognitive dissonance that people find aversive and actively work to dispel (Festinger, 1957; Festinger & Carlsmith, 1959).

In two studies, we explored whether visual perception is involved in the task of dispelling cognitive dissonance. We induced cognitive dissonance by having our participants perform an aversive task, but letting them feel like they had freely chosen to perform that act. In one study, participants walked across a university quad while wearing a costume reminiscent of the Brazilian dancer Carmen Miranda including a grass skirt, coconut bra, and fruit adorned hat. In another study, participants knelt on a skateboard and pushed themselves up a large grassy and somewhat muddy hill. We presumed that participants signing a contract affirming their free will in choosing to perform the task would feel more dissonance than those feeling that they had little choice in the matter, as well as those who did not have to perform the task at all.

We predicted that participants in the free choice conditions, who were feeling dissonance, would in part dispel that dissonance by seeing the task as less aversive. Specifically, those putting on the Carmen Miranda costume in free choice conditions would see the distance they had to walk as shorter than other participants. Those pushing themselves up a hill on a skateboard, under conditions of free choice, would see the hill as less steep. These predictions were confirmed. In their verbal reports and in their drawing of the environment in front of them, participants tended to report seeing an environment that was more benign. On average, participants who felt that they chose to wear the costume saw the distance they walked as 35% shorter than other participants. And those who chose to push themselves up the hill on the skateboard saw the hill as 17% less steep than other participants. Whatever motivational systems they had to quell dissonance appeared to alter their perception of the environment in an effort to diminish the distress associated with dissonance.

**Summary** Thus, positive motivated perception may be a member of the garrison defending the mind and body from the detrimental effects of negative information. Seeing the world favorably may deter from the otherwise oppressive presence of and consequential reaction to the great quantity and powerful punch of negative information. Positive motivated perception allows people to achieve their goals of feeling like a good person, in a benevolent world, with favorable prospects for the future. If no such defense system were in place, then it is quite possible that people might fall under the force of the slings and arrows that are tossed in their direction by a seemingly uncaring or threatening world.

### *Successful Goal Pursuit*

Wishful seeing can add functional value in another way. Wishful seeing could energize the perceiver to reach his or her goals. Biases in the perceptual system may help to facilitate actions meant to acquire needed or desired objects that fulfill motives, thus again serving an adaptive function.

**Seeing Good** Consider the evidence reviewed above that perceivers see desired objects (like water or money) to be closer to the extent that they can serve acute (e.g., the perceiver is thirsty) or chronic (e.g., who would not want to be richer?) goals. It is an age-old observation in psychology that the motivation to acquire a desirable object rises to the extent that the object appears closer (Dollard & Miller, 1950). Biased perceptions of closeness can further motivate the perceiver to acquire objects that are relevant to wishes and desires. If the distance appears reachable, then the perceiver may be more eager to use his or her resources to take on the task of approach. If, however, the object seems too far away, the perceiver may be less likely to expend the resources in attempts to reach it. Thus, motivations might lead the perceptual system into seeing a desired object as closer than it really is, thus encouraging behaviors meant to acquire that object.

**Seeing Bad** Just as important, though, is the ability to detect pitfalls, temptations, or features of the environment that are detrimental to a particular goal. Thus, reaching goals in an adaptive fashion means vigilance towards the bad as well as the good. Times in which undesired objects might also be seen as closer can energize avoidance of those objects. For example, if a snake slithers into a room inhabited by the perceiver, that perceiver's perceptual system might be biased to see the snake as closer as a way to motivate the perceiver toward escape.

Ultimately, then, successful goal pursuit may depend on how good a perceiver is at finding elements of the environment that assist in goal pursuit and avoiding elements that hinder goal pursuit. Finding tangy lemon gelato assists in the satisfaction of one's sweet tooth, just as finding the snake assists in the chronic goal of survival. Thus, perceivers may see as closer not only objects that assist in goal completion, but also those harmful elements of the environment that may derail a receiver from it.

To predict when a perceiver can engage in wishful seeing or should engage in vigilant seeing, we consider the consequences of misperception. If the consequences of misperceiving an object, particularly a negative one, are low, then allocating resources to gain rewards might outweigh the costs of attending to a negative stimulus. For instance, failing to see a bag of trash may not be as egregious an oversight as failing to notice an edible sandwich when hungry. These object-specific reactions might be the predictive force that reconciles the positivity–negativity dominance debate within motivated perception. People may see what they wish to see unless the alternative is an object that requires immediate attention in order to successfully navigate one's world.

**When Will Seeing Good Versus Bad Predominate?** To better predict when perceptual systems will be guided by wishful thinking rather than negativity dominance, it might be necessary to examine the specific emotion that is evoked within the situation. Being in the presence of a freshly collected sample of dog feces will rarely evoke the same emotional response as being in the presence of a tarantula that recently found the escape hatch from her tank and is freely roaming the tabletop. It is quite likely that the first object will be met with disgust reactions and the second with fear.

Although both disgust and fear are negative emotions and ones that produce arousal, disgust differs from fear physiologically as measured by neuroendocrine stress responses. Disgust decreases blood pressure and cortisol, the hormonal marker of stress, while fear increases blood pressure and cortisol (Lerner, Gonzalez, Dahl, Hariri, & Taylor, 2005). Arguably, increased blood pressure and cortisol suggest the body is prepared to take action. These biological markers suggest that although both disgust and fear are aversive affective states, fear is a motivating force that promotes action while disgust leads to withdrawal and inaction.

Given the physiological differences produced by fear and disgust, one might argue that these emotions should systematically bias action and perception systems. The presence of a feared object might activate a defense system that promotes action. If an alligator lay waiting in the swamps as a kayaker takes a morning paddle, that kayaker might be best served by noticing, attending to, and correctly identifying the animal so that she might take the actions necessary to remain out of harm's way. Alternatively, disgusting objects are less likely to require immediate action. To successfully navigate an environment that contains the rotting remains of a take-out box that once contained delicious tortellini with cream sauce, the hungry snacker perusing the fridge does not need to have her attention captured by the item. In fact, misinterpreting the moldy nuggets as lichen-covered rocks (that somehow made their way in to the kitchen) or not noticing the leftovers at all may prove more useful.

In other words, emotions vary in terms of the immediacy of the reaction that they require. Some emotions, such as fear, require a person to engage in action quickly to prevent a dangerous outcome. Other emotions, such as disgust, may not require immediate action to avoid harm. A feared object that requires immediate action might be noticed and accurately perceived, whereas disgusting objects that do not require immediate action can be distorted or left unattended at the will of the motivated perceptual system. Objects that evoke different emotions and behavioral reactions at various degrees of immediacy predict when wishful thinking rather than negativity dominance will lead to perceptual bias. In fact, a person might benefit by allowing the motivational system to activate coping strategies to deal with the disgusting although not immediately threatening situation.

Data from our labs suggests this may be the case. Participants stood across from a syringe lying on the table, and heard a description of where this needle came from. Some heard a fear-inducing description of the needle stating that it was from a Nevada medical clinic that the CDC found had been reusing needles and other similar hazardous medical procedures. Others heard a disgust-inducing description suggesting that the needle was from a box of needles that had been dumped onto the dirty floor in an emergency operating room and were being reused. Participants estimated that the distance between themselves and the needle was 20% shorter when the needle was described as fearful rather than disgusting or when it was described in a neutral manner (McWhirter & Balcetis, 2009).

## LIMITS ON WISHFUL SEEING

It is clear that people do not always see everything they would like to see in the environment. People, no matter how much they would like to see it, never see that million-dollar bill when they open their wallets. They do not see blue skies above as the calendar turns from October to November in the cities where they live. Reality does sneak heavily into visual perception. The features and properties of the natural environments do influence visual perception. If top-down wishes and motivations have an impact, that impact must be subject to a negotiation between the perceiver's goals and preferences and what the physical environment has to offer. Thus, there must exist limits to motivational influences on visual perception. Indeed, we can think of three such limits.

### Ambiguity in the Environment

In the experiments reviewed above, we deliberately introduced one property into the environment that we think is crucial for wishful seeing to occur. That property is that the stimulus in question be ambiguous – that is, open to several perceptual interpretations. We deliberately chose figures, like one that can be seen as the letter "B" or the number "13." Or we asked participants about aspects of the environment, such as distance to an object or the slope of a hill, that are open to interpretation.

Such motivational biases in perception might be reduced, or even eliminated, if the environment is less ambiguous. If a spot on one's skin is an inflamed and swollen mottled red lump it may be impossible for the visual system to see it as a rosy and healthy pink. The ambiguity of a stimulus can be constrained in two different ways. First, the stimulus itself might be crystal-clear. If that thing that looks like a horse has clear black and white stripes, the visual system may ably report that the animal is a zebra. If you must tip your head down to look at the zebra, then you are likely to be taller than that zebra. Second, the context surrounding the stimulus might constrain interpretations of what the stimulus is. If one is at a zoo, there is further evidence that that horsey-type thing is a zebra.

### Timing

Timing may also influence whether wishful seeing may take place. Much recent work has shown that people's thoughts are not always biased towards the favorable. In fact, for many decisions, people at first seek and strive for accuracy and realism. They adopt a *deliberative mindset*, in which they sample a wide variety of information in an open-minded and impartial way. It is only after committing to a decision that people switch to a biased search, in an *implemental mindset*, emphasizing the comfort of congenial information that supports the particular decision that has been made. Gollwitzer and colleagues (Gollwitzer & Kinney, 1989; Taylor & Gollwitzer, 1995), for example, have shown how people systematically move from realism to wishful thinking as they reach a decision.

Although we have not tested for it, timing may have a similar effect on visual perception. People trying to reach a decision may not be biased in how they see the world, but once a decision has been made, their perception of it might be shaped via wishful thinking. As an example, in trying to decide whom to choose for one's fantasy basketball team, one might realistically perceive the heights of the possible players one might choose from. However, once a player has been chosen, motivational influences on the visual system may kick in to see one's choice as taller. Future research could profitably explore this issue.

### *Accountability*

Personal accountability to others might also constrain top-down, motivational biases in the visual system. When people are asked to explicitly describe their perceptual experience to others, they might be more conservative in their reports. That is, they might hedge their bets, or see something that is not necessarily in their best interest, in order to protect themselves against the possibility of having claimed a more positive experience than is actually the case. There is much work on social psychology supporting the powerful role that accountability plays in canceling out the impact of one's own personal biases. If one has to reveal or justify one's conclusions to others, people tend to moderate those conclusions towards more accuracy (for an extensive review, see Lerner & Tetlock, 1999).

In fact, our data already informally suggest that personal accountability reduces the impact of wishes and preferences on visual perception. In one study, we collected both explicit self-reports and nonconscious eye-tracking measures of the perceptual experiences that participants had (Balcetis & Dunning, 2006, Study 3). The size of the effect of motivated perception varied a great deal depending on which measure was used. The effect size when measuring the influence of motivation on explicit self-reports of perceptual experience – the one reported to others – was a mere 0.6 standard deviation difference. However, the size of the effect nearly doubled when we looked at the nonconscious measure based on participants' gross level eye movements. When we looked at participants' first eye movements after viewing an ambiguous stimulus, and noted the percentage of time that eye movement was to a verbal label representing one interpretation of the stimulus over another (i.e., "farm animal" vs. "sea animal"), the size of the effect rose to 1.2 standard deviations (Balcetis & Dunning, 2006, Study 3). This suggests that personal accountability may lead participants to offer more conservative reports of their perceptual experience than the one initially offered by the visual system.

## CONCLUSION

In February 2006, Vice President Dick Cheney went hunting at the Armstrong Ranch outside of Corpus Christi, Texas. Unfortunately, Cheney failed to notice his friend and financial supporter, 78-year-old fellow hunter Harry Whittington, about 30 yards away before peppering him with a round from his 28-gauge shotgun (VandeHei & Moreno, 2006). It is difficult to imagine how Cheney missed his friend's obvious presence. How could Cheney have been blind to, mistaken, or interpreted the outline of a fellow hunter for the birds that were his target? Although the White House was not forthcoming with an explanation, it is possible that the complexity of the landscape, Whittington's unexpected presence, and

Cheney's quick reaction contributed to this unfortunate occurrence. Or perhaps Cheney quite literally saw Whittington as the quail (Quayle?) he was hunting.

Motivations do impact perception. The world people know, the one they act in and upon which their actions are based, is the one they take in through their senses. However, perceptions of the world are subject to influence from a host of characters much greater and much more broad-reaching than pure bottom-up details the retina is responsible for funneling. A plethora of preconscious processes including motivational urges mold, shape, twist, filter, and bias this information continuously throughout the many tasks perceptual systems undertake before people realize they have had a perceptual experience. Wishful thoughts, intra-psychic goals, and visceral desires, all of which are activated long before conscious awareness, are only a few among many of the forms that motivations can assume. The message is clear. Perceptual systems are penetrable. The world as we know it is not the world as it really is, for people come to know perceptual reality only as it appears through "the fetters of one's own ever-shifting desires" (Einstein, 1918).

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# 5

# Male or Female? An Investigation of Factors that Modulate the Visual Perception of Another's Sex

LUCY JOHNSTON, LYNDEN MILES, and C. NEIL MACRAE

One of the most fundamental aspects of social perception is the identification of the sex of others. Sex-based categorization occurs rapidly, spontaneously and accurately upon encountering another person (Stangor, Lynch, Duan, & Glas, 1992). The ability to identify sex develops very early in life, with infants as young as 5 months of age showing differential responding to faces of the same and different sex targets (Lasky, Klein, & Martinez, 1974), and children of 19 months being able to apply sex labels to photographs of adult faces (Leinbach, 1983). Further, the ability to differentiate male and female faces may have a specific neural locus as particular brain damage can result in individuals being impaired in the identification of sex from facial cues (Tiberghien & Clerc, 1986).

Such rapid and effective perception is consistent with the evolutionary importance of sex-based categorization. Survival may literally depend on an individual's ability to correctly identify, and procure, conspecifics for the purpose of reproduction. Central to the identification of potential reproductive partners is, of course, the identification of an individual's sex. Accordingly, perceivers should be attuned to the detection of information that will enhance the chances of reproductive success (see Miller & Todd, 1998), such as cues that specify sex. Despite the fundamental importance of sex-based categorization, however, the identification of the sex of another person may be of greater utility under some circumstances than others. In this chapter we provide evidence for the malleability of even this most basic of categorizations.

We describe a program of research that has investigated the functional nature of sex identification from facial information. We present evidence for the impact of biological influences (cyclical fluctuations in female fertility) and social/motivational influences on the efficiency of the person perception process. We first consider perceiver effects. We describe a number of experiments that have demonstrated that both biological and motivational factors can influence the efficiency, the speed and accuracy, with which female perceivers identify males. We then consider target effects. We describe two experiments that have demonstrated that the efficiency of both male and female perceivers in categorizing the sex of others is influenced by facial features of the targets.

## PERCEIVER EFFECTS

In this section we consider the impact of biological (specifically hormonal) influences and social influences on the efficiency of perception of the sex of strangers by female perceivers. We demonstrate that levels of female hormones influence the efficiency with which they identify males. Further we show that the impact of hormonal factors can be modulated by social or motivational influences. Specifically we considered the impact of the use of oral contraceptives and the impact of sexual orientation.

### *Biological/Hormonal Influences*

Hormonal forces are known to play a prominent role in information processing and response generation (Erlanger, Kutner, & Jacobs, 1999; Krug, Plihae, Fehm, & Born, 2000). Accordingly, we predicted that hormonal fluctuations associated with the female menstrual cycle would also influence the efficiency of sex-categorization, the speed or ease with which perceivers identify the sex of a stranger.

A female experiences high conception probability for only a relatively short period of time during each menstrual cycle, and for a limited period of the lifespan, between menarche and menopause. In the period between menarche, which usually occurs between 11 and 13 years of age, and menopause, which usually occurs between 45 and 55 years of age, a female experiences high conception probability for only an average of 2–3 days during each menstrual cycle, which lasts approximately 21 to 36 days. The days of high conception probability within each menstrual cycle correspond with ovulation. It is potentially very important that these reproductive opportunities be seized. Although females may evaluate the suitability of males as reproductive partners at all stages of their menstrual cycle, it is possible that they are especially attuned to do so during times of high fertility (ovulation), when such information is most relevant for reproductive success, and when the consequences of an incorrect judgment are the most drastic. Certainly women's sexual desire peaks during periods of high fertility (for reviews see Hill, 1988; Pawlowski, 1999; Streklis & Whiteman, 1989; Wood, 1994) when women report an increased incidence, and initiation, of intercourse, including extra-pair copulation, and increased levels of masturbation and sexual thoughts and fantasies (Baker & Bellis, 1995; Bancroft, Sanders, Davidson, & Warner, 1983; Harvey, 1987; Hill, 1988; Matteo & Rissman, 1984; Zillmann, Schweitzer, & Mundorf, 1994).

An extensive literature has clearly demonstrated that female mate preferences have an adaptive focus. Females show greater attunement to features that will enhance reproductive success during periods of high than low fertility. Women's sensitivity to, and evaluation of, markers of "maleness" fluctuates across the menstrual cycle, with more positive evaluation of markers of maleness during periods of high fertility. For example, androstenol, an important contributor to male body odor, is evaluated more favorably by women when they are at the ovulatory (i.e., high fertility) phase of their menstrual cycle (Grammer, 1993). Similarly, women prefer more masculinized and less feminized male faces, and more symmetrical male faces during ovulation than during other phases of the menstrual cycle (Fink & Penton-Voak, 2002; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). Faces with these preferred features have been associated with better health (Rhodes, Chan, Zebrowitz, & Simmons, 2003), and with higher testosterone concentrations amongst males (Roney, Hanson, Durante & Maestripieri, 2006; see Penton-Voak & Perrett, 2001 for a review). Testosterone concentrations, and hence facial masculinity, has been proposed as a proxy for genetic quality on the basis of evidence that higher levels of testosterone result in more masculine facial features and that high levels of testosterone can only be sustained by healthier men since testosterone has immunosuppressive effects (Følstad & Karter, 1992; Grammer & Thornhill, 1994). Cycle-dependent sensitivity does, then, offer reproductive benefits to the female.

These studies were concerned with evaluations of the attractiveness of target males as reproductive partners, or with expressions of preference for one target over others. They did not address the more basic question of whether or not a target is a potential reproductive partner (i.e., is a sexually mature male), and hence whether their reproductive quality needs to be assessed. We address this question by considering whether the speed of sex-based categorization is influenced by female hormonal (or fertility) levels.

Macrae, Alnwick, Milne, and Schloerscheidt (2002) investigated the efficiency of sex-based categorization as a function of fertility level. Female participants were presented with facial photographs of unknown men and women on a computer screen and asked to identify each as either male or female. Each participant completed this task twice, once at ovulation and once at menstruation. As predicted, person categorization was facilitated during the phase of high fertility, but only for male targets. Women were faster to categorize male photographs during periods of high than low conception probability, but showed no difference in speed to categorize female faces. In addition, women were faster to categorize males than females in periods of high fertility but showed no difference in categorization speed for male and female faces during low fertility. In other words, women displayed enhanced sensitivity for reproductively relevant stimuli (sexually mature male faces) during the phase of the menstrual cycle when conception probability was highest. These results provided an important initial demonstration that even a basic aspect of person perception, such as identifying the sex of others, is influenced by biological characteristics (fertility levels) of the perceiver.

If the enhanced sensitivity to reproductively relevant stimuli (i.e., male faces) reported by Macrae et al. (2002) is related to changes in conception likelihood, then only those women experiencing cyclical changes in fertility should show an interaction between testing session and sex of the target faces (Gangestad

& Thornhill, 1998; Penton-Voak et al., 1999). That is, the effects reported by Macrae et al. (2002) ought not be present among women who do not show fluctuating fertility. Two such groups are pregnant women and women taking oral contraceptives. For these individuals, conception risk is no longer a pertinent issue; hormonal changes associated with pregnancy and with oral contraception result in no, or very low, conception risk and no cyclical fluctuations in fertility. We tested a group of women who were taking a combination (estrogen and progesterone) contraceptive pill that results in a cyclical pattern of monthly bleeding akin to menstruation but is not accompanied by fluctuations in fertility, as well as a group of pregnant women and a control group of regularly ovulating women (Johnston, Arden, Macrae, & Grace, 2003). Each participant completed our sex-categorization task twice. Regularly ovulating women were tested once at ovulation when reproductive capacity is high and once at menstruation when reproductive capacity is low. Women on the contraceptive pill were tested once at mid-cycle and once at "menstruation" (bleeding), and pregnant women were tested on two occasions 14 days apart. If the enhanced sensitivity to reproductively relevant stimuli (i.e., male faces) reported by Macrae et al. (2002) is an adaptive process, associated with changes in fertility, then this effect should be evident only for those women experiencing cyclical changes in fertility and not for either the pregnant women or the women on the contraceptive pill. Mean response times are shown in the first three panels of Figure 5.1 for each participant group.

The results from this study replicated those of Macrae et al. (2002) with regularly ovulating women again being faster to categorize males during periods of high than low fertility but showing no difference in speed of categorization of female targets as a function of fertility level. Enhanced female sensitivity to reproductively relevant (i.e., male faces) stimuli was seen only in periods in which such sensitivity may have adaptive benefits. Furthermore, consistent with these findings, pregnant women, who are in a (temporary) state of zero conception risk, showed no effects of either target or testing session. These findings are in line with the dominant theoretical framework of categorization as a functional, adaptive process. The findings for the women on the pill do not, however, fit easily within this framework. Women on the pill were tested twice, at stages parallel to those of high and low fertility for the female participants – that is, at mid-cycle and at "menstruation." That these women showed no differences in performance across testing sessions reinforces the importance of fertility levels and the associated hormonal fluctuations on person construal. It is also consistent with the previous finding that women on oral contraceptives show no cyclical shifts in the perceived attractiveness of potential sexual partners, in contrast to women not on the contraceptive pill who do display such an effect (Penton-Voak et al., 1999). Unexpectedly, however, women on the pill showed enhanced sensitivity to the male photographs, being faster to categorize male than female faces at both testing sessions. Despite being in a continual state of low fertility, due to the hormonal changes brought about by oral contraceptives, women on the pill showed enhanced sensitivity to male faces, similar to that of regularly ovulating women during periods of high fertility. Further, levels of the specific female reproductive hormones (estrogen and progesterone) cannot explain the reported effects. For women using a combination contraceptive pill, levels of both estrogen and progesterone are relatively high through the first 21 days of the cycle. The high level of progesterone in this period inhibits the secretion of follicle stimulating hormone (FSH) and luteinizing hormone (LH) such that no egg is released. In the final 7 days of the cycle, the "break-out" period of bleeding, levels of both hormones are drastically reduced. However, these women showed a similar pattern of responding at mid-cycle and bleeding, despite substantive differences in the levels of each hormone between the two testing sessions. Regularly ovulating women show an increase in estrogen over the first 14 days of the cycle with the peak coinciding with a peak in FSH and LH just prior to ovulation. Levels of oestrogen then dramatically decrease over the next 14 days of the cycle. Progesterone levels are low until ovulation and then increase for approximately 7 days before decreasing (if the egg is not fertilized). Levels of estrogen and progesterone are also comparable for pill-taking and regularly ovulating women at menstruation/break-out bleeding but at this testing session the pattern of results differed most between these two groups of women. Although fluctuating fertility clearly modulates the efficiency of person construal, it does so in combination with a variety of other factors.

Motivational forces associated with use of a contraceptive pill may also play a role in the efficiency of the person perception process. Previous research has demonstrated a strong impact of motivational factors on related tasks. For example, relationship status can influence mate preferences (Penton-Voak et al., 1999). Although there are a number of reasons for women taking a contraceptive pill (e.g., to treat acne; to regulate menstruation), the primary motivation for so doing is to minimize the risk of pregnancy while being sexually active. Taking the pill explicitly decouples sexual activity and conception likelihood. This reduced risk of impregnation could conceivably remove a major inhibitor of sexual activity. Indeed, women on the pill engage in intercourse and other sexual activities more frequently than do sexually active but non-pill-taking women (McCoy & Matyas, 1996). That is, sexual behavior is driven by motivational factors, not solely by biological forces. It is possible, therefore, that the sexual freedom associated with oral contraception sensitizes pill-taking females to men and to markers of maleness. This motivational explanation may not be restricted to women taking oral contraception, however. Ovulation could be considered to be a period of high sexual *desire* rather than high conception *desire/probability* for regularly ovulating women, as evidenced by higher sexual arousal and frequency of intercourse at this time (Baker & Bellis, 1995; Bancroft et al., 1983; Hill, 1988; Matteo & Rissman, 1984; Zillmann et al., 1994). This high sexual *desire* might drive their sensitivity to men and to markers of maleness. Women on the pill may be in a relatively high state of sexual desire at all times, whereas for normally ovulating women sexual desire peaks at ovulation, coinciding with a peak in conception risk.

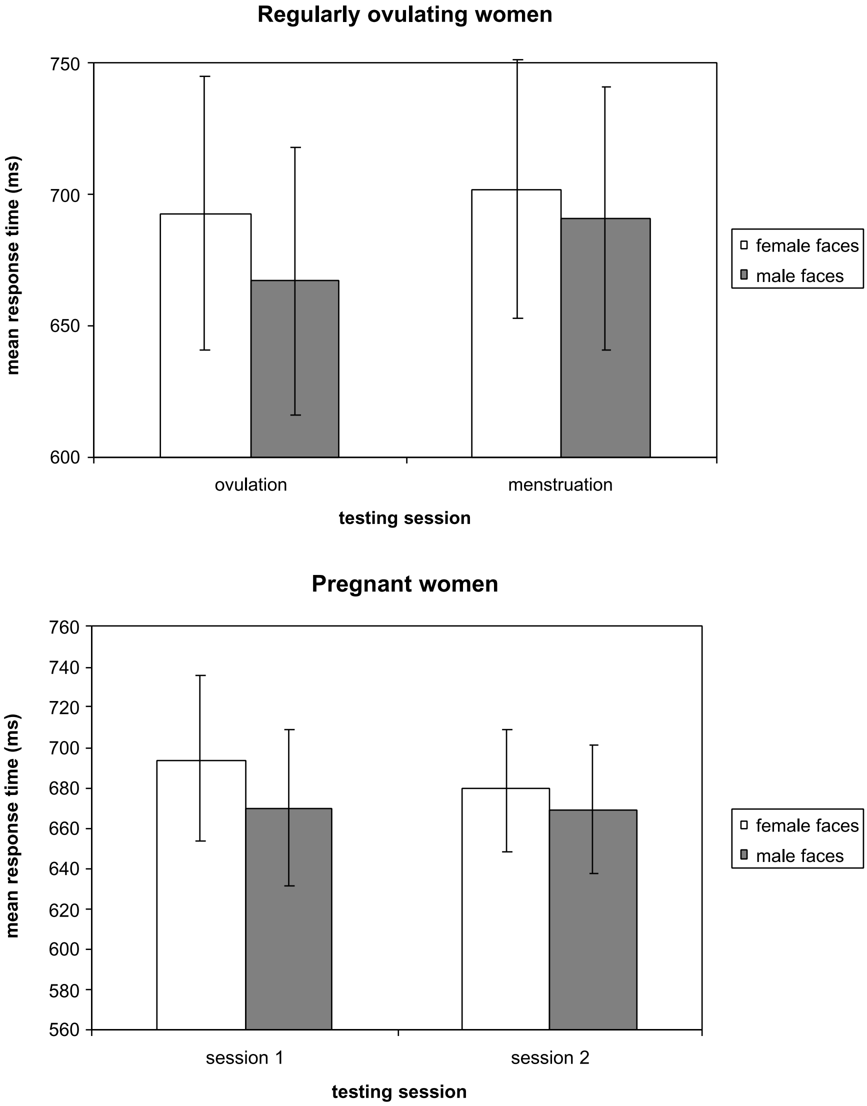

FIGURE 5.1 Mean response times as a function of participant group, sex of photographs and testing session (from Johnston et al., 2003 and Brinsmead-Stockham et al., 2008, copyright © 2008, with permission from Elsevier).

## *Sexual Orientation*

Consistent with a functional, evolutionary perspective, the findings of Macrae et al. (2002) and Johnston et al. (2003) demonstrated that biological factors associated with reproductive likelihood influence the efficiency of sex-based categorization. However, results from women on the pill indicate that hormonal

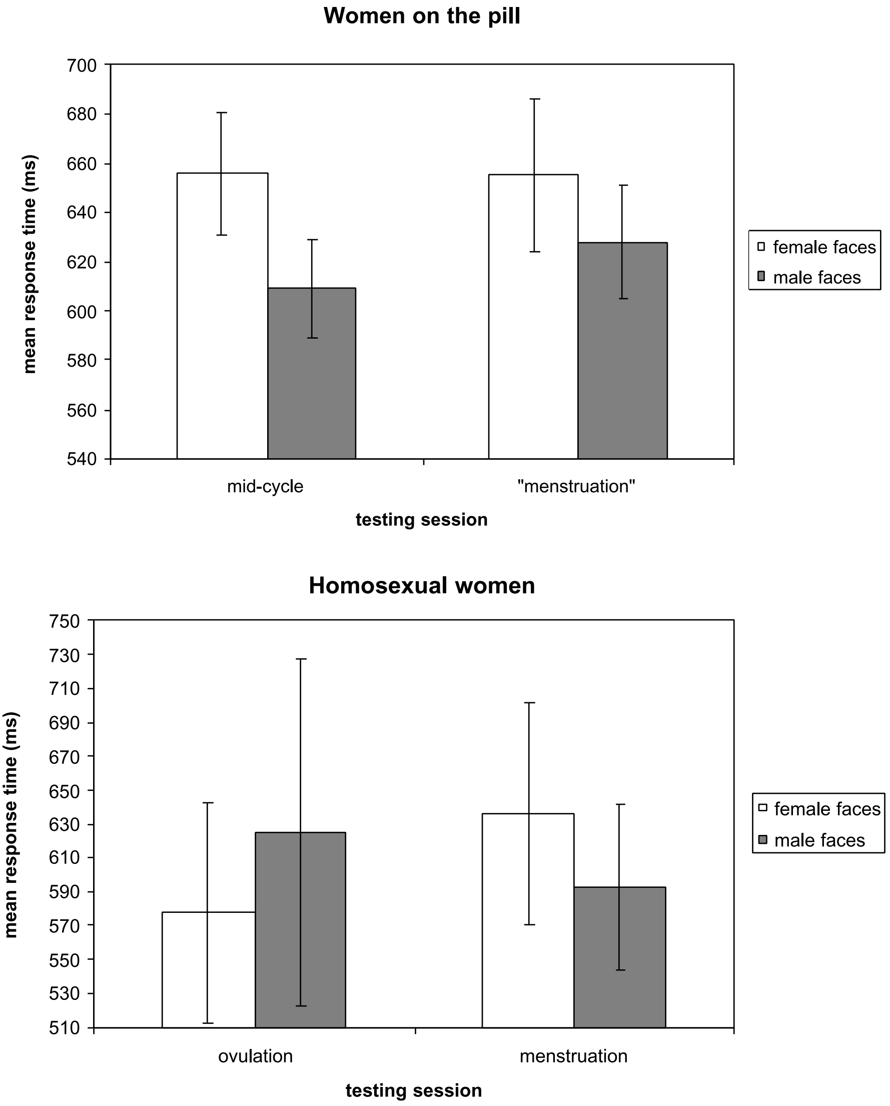

FIGURE 5.1 Continued

factors alone cannot account for differences in categorization speed. Rather, person perception appears to be driven by an interplay between biological and motivational forces. In a further demonstration of the impact of motivational factors on female perceivers, we considered the impact of female sexual orientation on sex-based categorization (Brinsmead-Stockham, Johnston, Miles, & Macrae, 2008).

We tested a group of lesbian participants who were maintaining a regular menstrual cycle and were not using hormonal contraception. Cyclical fluctuations in fertility level for this group of participants are identical to those of heterosexual women not using hormonal contraceptives. Like heterosexual women, homosexual women have been shown to have a peak in orgasm, self-initiated sexual encounters and total sexual encounters at ovulation (Burleson, Trevathan, & Gregory, 2002; Matteo & Rissman, 1984). Indeed, it has been shown that the total frequency of sexual behaviors is similar for homosexual and heterosexual women, although the percentage of autosexual behaviour is higher among homosexual women, and that the two groups show a similar level of increase in total sexual behaviour at ovulation (Burleson et al., 2002; Schreurs, 1993). Accordingly, we predicted that, like heterosexual women, lesbians would show differences in their speed to identify the sex of unknown faces as a function of fluctuations in hormonal, and hence fertility, levels. An explanation based on conception likelihood would lead to the prediction that, like heterosexual women, lesbian women would show greater sensitivity (i.e., faster identification times) to male but not to female faces at high than at low fertility. An explanation based on sexual desire would lead to the prediction that lesbians would show enhanced sensitivity to female but not to male faces in periods of high fertility. Results are shown in the bottom panel of Figure 5.1.

The performance of the lesbian participants on a sex-categorization task was influenced, as predicted, by the stage of their menstrual cycle. The women showed differential response times at ovulation compared to at menstruation, but only for female faces. Homosexual female perceivers were faster to identify female faces during periods of high than low fertility. That is, the women showed enhanced sensitivity to markers of femaleness during periods of high fertility (i.e., ovulation). These findings in large part parallel previous research with heterosexual women who showed enhanced sensitivity to markers of maleness at high fertility (Johnston et al., 2003; Macrae et al., 2002) and are consistent with an explanation based on levels of sexual desire and activity. Sexual activity has been shown to be greatest for women, both homosexual and heterosexual, around ovulation (Baker & Bellis, 1995; Burleson et al., 2002; Harvey, 1987; Hill, 1988; Matteo & Rissman, 1984) and hence women should be especially attuned to sexually relevant information at this time. For heterosexual women this results in enhanced sensitivity to markers of maleness (Johnston et al., 2003; Macrae et al., 2002) and for lesbians in enhanced sensitivity to markers of femaleness. The present findings do not sit well, however, with an explanation based on conception likelihood, or fluctuating fertility levels. If conception likelihood were the guiding influence on the sex-categorization task then homosexual women should show enhanced sensitivity to markers of maleness, rather than femaleness, during periods of high fertility. Similarly, the findings cannot be explained in terms of levels of sex-specific hormones, as the menstrual cycle pattern of hormonal fluctuations does not differ as a function of sexual orientation. The timing of enhanced sexual activity may be hormonally driven, and independent of sexual orientation, but the target of that enhanced activity cannot solely be a function of hormonal fluctuations across the female menstrual cycle.

The results of this experiment again demonstrated the impact of fluctuating fertility on social perception among female perceivers and are consistent with an explanation for enhanced sensitivity to sexually relevant faces in terms of levels of sexual desire and sexual relevance, rather than reproductive relevance.

### Categorization Errors

Our focus thus far has been on the speed of correct sex-based categorizations of male and female faces and the impact of characteristics of the perceiver, specifically their fertility levels and sexual orientation. The sex-categorization task employed in each of the studies described thus far (Johnston et al., 2003, 2009; Macrae et al., 2002) has presented head and shoulders images that remain on the screen until the participant has responded. Accordingly, error rates are very low (<1% of trials). Of course in many everyday settings strangers are not viewed under such ideal conditions, but rather the sight of another person might be occluded, or may be a fleeting glance as a person passes by the perceiver. In such situations perceivers have a limited viewing opportunity. Correct detection of characteristics of the target, such as their sex, requires perceivers to attend quickly to the relevant information. Failure to do so may result in perceptual errors. Those characteristics of targets that are most accurately identified under such limited viewing conditions, it could be argued, are those that are most salient, most functional, and to which the perceiver most quickly attends. Another experiment in our series (Johnston, Miles, & Macrae, 2008) investigated the extent to which the sex of targets is such a characteristic, by considering the accuracy of sex identification under limited viewing conditions. In order to increase the error rate in the present experiment, each target photograph in a sex-categorization task was presented only briefly (for 50 ms) before being replaced by a pattern mask such that the perceiver had only a short time to view each target and attend to information specifying sex.

Considering sex-based identification in terms of reproductive opportunities, incorrect identification of a target's sex may incur costs for female perceivers. Such incorrect identifications can take two forms – either misperceiving a male target as female or misperceiving a female target as male. The former can be considered to be a "false negative" error and the latter a "false positive" error. Both types of error may incur costs. A false negative could result in a missed reproductive opportunity. A false positive may result in the expenditure of resources (e.g., time and effort) on a non-reproductively relevant partner, which might also result in reduced opportunity to identify and procure a potential mate. We investigated the relative incidence of false positive and false negative errors at both high and low fertility. Given the costs of misperception to female perceivers, it was expected that fewer errors would be made when perceivers were tested at high than at low fertility.

According to error management theory (Haselton & Buss, 2000), decision-making processes have evolved through natural or sexual selection to lead to the commiting of predictable errors. When there are costs associated with two types of error, there should be a bias toward committing those errors that are less costly, even if that leads to the commiting of a greater total number of errors. It is unclear, however, whether the costs associated with a missed reproductive opportunity (i.e., false negatives) would exceed the costs of misdirected resources (i.e., false positives) or vice versa. One might hypothesize that, assuming an adequate supply of males within a given population, during periods of high fertility females may err towards false negatives (i.e. risk misidentifying males as females) in order to maintain a strategy of selectivity. Indeed, women have been shown to exert increased selectivity in (speed) dating as a function of the number of mate choices available (Fisman, Iyengar, Kamenica, & Simonson, 2006). While this will risk missing potential reproductive partners, if the decision strategy employed takes some account of factors associated with male reproductive quality, candidates with low quality could be excluded at this initial stage of partner identification. Alternatively, it might be argued that women should err towards false positives in an attempt to identify all males. Such inclusivity would, however, subsequently require some means to assess mate quality. We tested these hypotheses by requiring female perceivers to complete the modified sex-categorization task (Walton, 2002) twice, once at ovulation and once at menstruation. Error rates are shown in Figure 5.2.

Contrary to predictions, there was no effect of phase of menstrual cycle on the number of errors made by perceivers. Despite the greater costs of errors, in terms of reproductive capability, at high than at low fertility, perceivers' accuracy rates did not differ as a function of their fertility level. However, there was a greater incidence of false negative than false positive errors at both high and low fertility. That is, female perceivers were more likely to miscategorize a male as a female than miscategorize a female as a male. Following from error management theory (Haselton & Buss, 2000), this finding would suggest that the costs associated with false positive errors are in fact greater than the costs associated with false negative errors. The costs associated with investment in a non-reproductive partner seemingly outweigh those of missing the opportunity to mate with a potential reproductive partner. One possible explanation for this finding is that the availability of males (potential reproductive partners) is sufficient that the costs of missing some

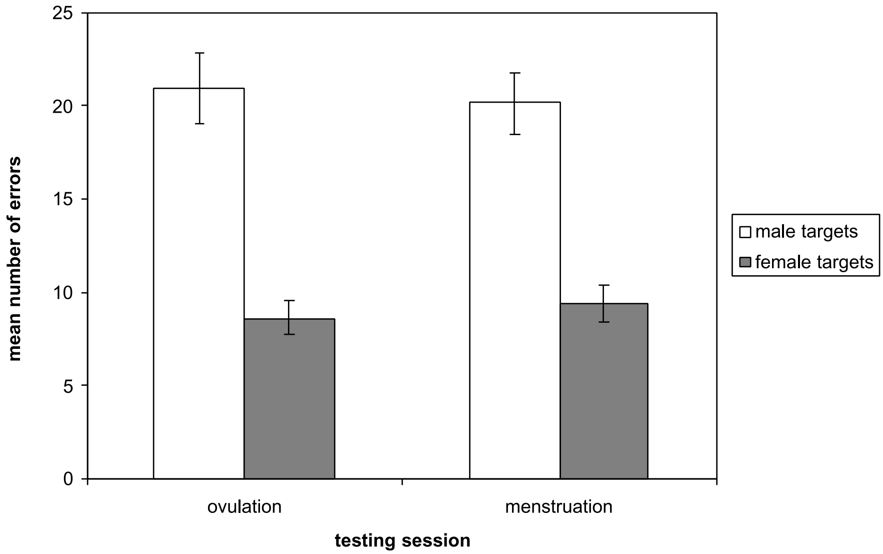

FIGURE 5.2 Mean number of errors as a function of sex of photograph and testing time (data from Johnston et al., 2008).

reproductive opportunities (false negative errors) are less than in situations where potential reproductive partners are scarce. Indeed, in situations of multiple reproductive options, there may be greater differentiation of the possible reproductive opportunities such that each is not considered to be an equal opportunity. In these cases not all missed reproductive opportunities might be considered to be equally costly.

Taken together, these experiments provide evidence for perceiver effects on sex-based categorization. A variety of characteristics of female perceivers – the stage of their menstrual cycle, their use of oral contraceptives, their sexual orientation – have been shown to influence the efficiency with which female perceivers correctly identify male strangers as male. The reported findings are all consistent with an explanation based on current level of sexual desire. When sexual desire is high, females are more highly attuned to sexually relevant targets than when sexual desire is low.

### *Target Effects*

Not all faces are created equal. Importantly, faces differ in their masculinity and femininity and in overall attractiveness. As noted above, there is an extensive literature demonstrating that females display preferences for more masculinized and less feminized features during ovulation than at other phases of the menstrual cycle (Fink & Penton-Voak, 2002; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). Further, those features preferred by women at ovulation have been associated with better health (Rhodes et al., 2003), and with higher genetic quality among males (Roney et al., 2006; see Penton-Voak & Perrett, 2001 for a review). Facial masculinity has been proposed as a signal of genetic quality on the basis of evidence that higher levels of testosterone result in more masculine facial features and that high levels of testosterone can only be sustained by healthier men since testosterone has immunosuppressive effects (Følstad & Karter, 1992; Grammer & Thornhill, 1994). Cycle-dependent sensitivity does, then, offer reproductive benefits to the female. Our research reviewed thus far has not considered the reproductive quality of the targets, but simply whether they were male or female. That research showed that regularly ovulating females are especially attuned to facial features that specify "maleness" at ovulation, but it is unclear whether they are also attuned to features that specify the reproductive quality of the potential targets. In this section we consider the results from two experiments that have addressed the question of perceiver attunement to information specifying the reproductive quality or readiness of others. We first consider whether the efficiency with which female perceivers correctly identify males is influenced by the reproductive qualities of those males, as specified in their facial features. In the second experiment we consider whether male perceivers are sensitive to the reproductive readiness (fertility level) of female targets.

## Male Facial Features

We considered the relationship between female perceivers' accuracy in sex categorization and male facial features, as a function of the perceiver's phase of their menstrual cycle (Johnston et al., 2008). Based on the mate preference literature, it was predicted that female perceivers would be more accurate in identifying good quality males at ovulation than at menstruation. To test this prediction, each of the target photographs was rated by independent raters according to levels of perceived masculinity, femininity, and attractiveness. Since combinations of high masculinity/low femininity and high attractiveness have been associated with higher genetic quality among males (Følstad & Karter, 1992; Møller & Thornhill, 1997; Rhodes et al., 2003; Thornhill & Gangestad, 1999), we predicted that there would be negative correlations between the number of errors made for male targets and ratings of attractiveness and masculinity of those targets. Further, it was predicted that these correlations would be stronger at ovulation than at menstruation.

Given the high negative correlation between ratings of masculinity and femininity, a composite measure was computed with higher scores indicating more masculine/less feminine faces. Correlations between error rates on the sex identification task and ratings of masculinity and attractiveness are shown in Table 5.1.

At high fertility, the negative relationship between masculinity ratings and error rate approached significance; female perceivers made fewer errors in categorizing male targets the more masculine those targets were considered to be. At low fertility, however, there was no relationship between error rate and ratings of masculinity. These findings are consistent with the mate preference literature that has shown females to prefer more masculinized and less feminized faces only at ovulation and not at other phases of the menstrual cycle (Fink & Penton-Voak, 2002; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). When male targets were visible for only a limited time period, female perceivers at ovulation were more accurate at identifying more masculinized targets, suggesting that they were more highly attuned to such information under these conditions. The weak overall relationships between error rates and characteristics of male faces seen in this study may be a consequence of low variability in the target faces used. All of the target photographs depicted healthy young males who were rated to be of moderate attractiveness, such that all were potentially viable reproductive partners. If more extreme faces were included in the target set, especially male faces of very low attractiveness, it is possible that stronger relationships would have been found (Zebrowitz & Rhodes, 2004).

TABLE 5.1 Correlations between errors and the composite rating of masculinity and ratings of attractiveness as a function of testing session

| | **Ratings** | |
|---|---|---|
| | *Composite masculinity* | *Attractiveness* |
| Menstruation | −.017 | .108 |
| Ovulation | −.267* | −.040 |

* $p = .06$

### Female Facial Features

In contrast to females, males experience no short-term cyclical variation in fertility equivalent to the female menstrual cycle and they remain reproductively viable for most of their adult lives. In addition, impregnation of one female does not alter a male's level of fertility, nor does it prevent them from impregnating other females. Accordingly, time-dependent reproductive pressures on males are less intense than those on females (Buss, 1994; Symons, 1979). Sensitivity to females' fertility levels would still, however, enhance the reproductive success of males. Mating with a female during a period of high fertility, or indeed simply identifying females who are potentially fertile, would increase the likelihood of fertilization and subsequent impregnation as a consequence of intercourse. Accordingly, we considered whether these same fluctuations can influence the efficiency with which male perceivers identify the sex of female faces.

There are potentially two informative periods for males within a woman's menstrual cycle. Ovulation specifies a period of high fertility, such that immediate copulation would enhance chances of reproductive success. Menstruation is a period of low fertility, but it is a marker of fecundity, that is, of potential reproductive capacity or the ability to reproduce. As early as the writing of the Roman physician Soranus of Ephesus (AD 98–138) it has been recognized that only women who menstruate are capable of conception (Temkin, 1991). Sensitivity to markers of menstruation may, then, allow males to identify potential reproductive mates. Given that reproductive pressures on males are less intense than those on females, and that females tend to be the gate-keepers of intercourse, this identification of potential, rather than immediate, reproductive partners may be sufficient to boost overall reproductive capability.

While ovulation has traditionally been considered to be concealed in humans (Burley, 1979), anecdotal reports suggest that women are aware of many physical changes that occur to their bodies around both ovulation and menstruation. Furthermore, several of these changes may be detectable by perceivers. For example, males have been shown to be sensitive to changes in odor associated with the female menstrual cycle. Males find body odors collected from both their partner and strangers most pleasant and sexy when they are collected during the ovulatory phase of the menstrual cycle (Poran, 1994; Singh & Bronstad, 2001). Fluctuating fertility levels may, then, influence male mate preferences. Of course, it may not always be possible for males to gain access to the olfactory cues that accompany ovulation, as this involves close proximity to the female. It would be useful, therefore, if males were sensitive to other markers of fluctuating fertility, markers that are more readily accessible, such as visual cues. Recent research has identified two such physical changes that may be perceived by others – cyclical changes in soft tissue asymmetry and in skin condition.

Symmetry of soft tissues (e.g., of breasts, ears, and digits) fluctuates with fertility levels (Manning, Scutt, Whitehouse, Leinster, & Walton, 1996; Scutt & Manning, 1996), specifically with ovulation. Women show a marked decrease in asymmetry, by roughly 30%, in these soft tissue regions on the day of ovulation and it was only at this point in the cycle where asymmetry changed significantly (Manning et al., 1996; Scutt & Manning, 1996). The mid-cycle peak in cyclical symmetry coincides with brief increases in FSH, LH, and oestradiol, which are hormonal changes that are restricted to ovulating women. Further, it is known that changes in soft tissue volume occur as a response to cyclical secretion of the combination of these sex steroids (Milligan, Drife, & Short, 1975). Men have been shown to be sensitive to quite small differences in the asymmetry of female facial traits (Gangestad, Thornhill, & Yeo, 1994; Grammer & Thornhill, 1994), so it is conceivable that a decrease in asymmetry is a perceptible marker of ovulation. Greater facial symmetry has also been associated with higher perceived attractiveness (Perrett et al., 1999; Rhodes, Proffitt, Grady, & Sumich, 1998), such that females show a peak in facial symmetry, which is associated with higher perceived attractiveness, during periods of high fertility. Accordingly females are perceived to be most attractive at times when their sexual desire is highest.

Female skin color and texture also fluctuate with the menstrual cycle, and may provide markers of both ovulation and menstruation. The skin is lightest, smoothest and most free of blemishes near ovulation (Fink, Grammer, & Thornhill, 2001; Frost, 1988; Symons, 1995). Changes in skin condition are also seen at menstruation, when the skin becomes darker (Frost, 1988) and there are more blemishes (Magos, 1988). Accordingly, peaks and troughs in skin condition are markers of both ovulation and menstruation, good skin texture (free of blemishes) being associated with ovulation and poor skin texture (evidence of blemishes) with menstruation. Men have been shown to be sensitive to changes in skin texture in distinguishing fertile post-pubescent females from infertile pre-pubescent ones (van der Berghe & Frost, 1986), so changes in skin texture and color may also provide perceptible cues to cyclical changes in fertility level.

We investigated whether men are sensitive to cyclical changes in female fertility (Johnston, Miles, Carter, & Macrae, 2005), again using a sex-categorization task (Walton, 2002). In order to differentiate between sensitivity to markers of ovulation and of menstruation we included two groups of target females – regularly ovulating women and women using a combination contraceptive pill. Each of the women had her photograph taken twice, once at ovulation/mid-cycle and once at menstruation/bleeding. As discussed above, women taking a combination contraceptive pill maintain a cyclical pattern of monthly bleeding akin to menstruation, although this is not associated with any fluctuations in fertility levels. It is noted that the reductions in hormone (estrogen and progesterone) levels at menstruation are similar for both normally ovulating woman and women on the pill. Skin changes as a function of hormonal changes at menstruation should, then, be similar for both groups. Indeed, for our target females, the incidence of skin blemishes was greater at ovulation/mid-cycle than at menstruation for both the normally ovulating women and women using a contraceptive pill. An index of fluctuating asymmetry was computed from the difference in length between the left and right ears at each photography session (Manning et al., 1996). For women on the pill there were no differences at all between sessions (mid-cycle and "menstruation"), which is consistent with fluctuating asymmetry being a marker of ovulation and being associated with changes in levels of FSH and LH, which are restricted to ovulating women (Manning et al., 1996; Scutt & Manning, 1996). Each of the normally ovulating target women did show a difference in asymmetry between the sessions, with asymmetry lower at ovulation than at menstruation.

If men are sensitive to physical changes at ovulation or menstruation, quite different effects would be expected to emerge in the current person-construal task. If men are sensitive to markers of ovulation (i.e., clear skin; greater ear symmetry), an interaction between target group (ovulating women vs. women on the pill) and photograph time (ovulation/mid-cycle vs. menstruation/bleeding) should arise. Perceivers should be faster to categorize regularly ovulating women at ovulation than at menstruation, but no effect of photograph time should emerge for women taking the pill. In contrast, if men are sensitive to markers of menstruation, a main effect of photograph time should emerge. That is, participants should be faster to categorize both groups of women at ovulation/mid-cycle than at menstruation/bleeding.

Results revealed only a main effect of photograph time, as shown in Figure 5.3. Male perceivers were faster to correctly identify the sex of women at menstruation/bleeding than at ovulation/mid-cycle. These results are consistent with our general prediction that men are sensitive to fluctuations in fertility levels of unknown females. Unexpectedly, however, categorization of women was faster during the period of low fertility (for the regularly ovulating women) than during the period of high fertility. In addition, a similar pattern was seen in responding to women on the pill who have no fluctuations in their fertility levels, but do show changes in skin quality similar to those of regularly ovulating women.

It would appear, then, that males are sensitive not to markers of current high fertility (ovulation) but rather to markers of longer-term fertility or reproductive viability (menstruation). The markers of both ovulation and menstruation

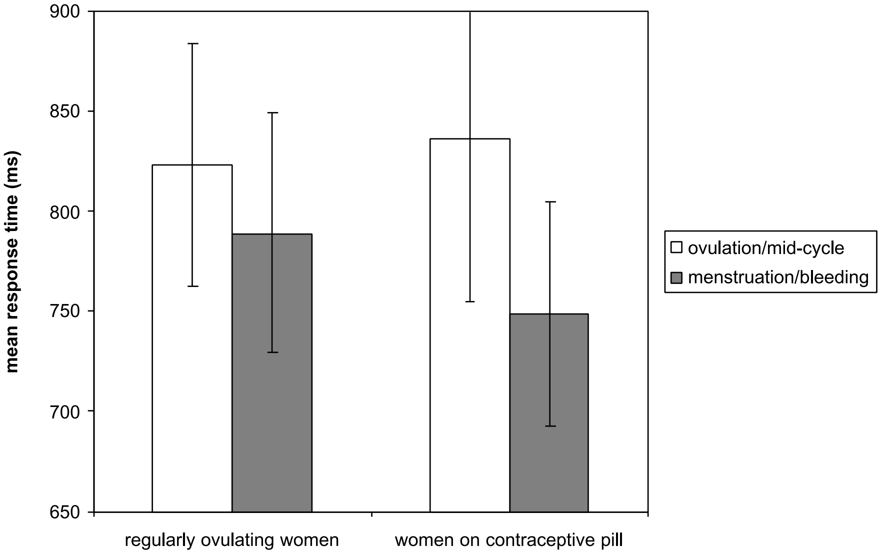

FIGURE 5.3 Mean response times as a function of photograph category and fertility level (data from Johnston et al., 2005).

are relatively subtle, although those of menstruation may be more salient to perceivers. The existence of skin blemishes at menstruation may be more easily perceptible than their absence at ovulation. Not surprisingly, female faces at ovulation, which are freer of blemishes and are more symmetrical, are judged to be more attractive than at other phases of the menstrual cycle (Roberts et al., 2004). We argue, however, that our results are not simply a reflection of male sensitivity to attractiveness since males were faster to identify women at menstruation – that is, less attractive women – than the more attractive women at ovulation.

The asymmetry of non-sex-selected soft tissues (e.g., ear length) may also be less pertinent to perceivers than that of other sex-selected soft tissue (e.g., breasts), which were not shown in our stimuli (cf. Thornhill & Gangestad, 1994). Given that the reproductive pressures on males are less intense than those on females, however, this identification of potential rather than immediate sexual partners may offer a number of benefits. Detecting peak fertility is one thing, but gaining access to a woman at precisely this moment may be an altogether different matter. In contrast, sensitivity to the general fertility of females likely enhances the chances of long-term reproductive success, as sexual contact can be postponed until some future opportunity arises (e.g., the female is accessible). Identifying a target as a potential reproductive partner provides the perceiver with the opportunity to engage in courtship behaviors in order to increase the likelihood of reproductive opportunities in due course (i.e., at ovulation).

Our research involved the categorization of unknown females. Although we showed males to be sensitive to fertility fluctuations in strangers, it is possible that the markers of fertility to which males are sensitive are different for familiar and unfamiliar targets. Given that cyclical changes account for only approximately 20% of the population variance in asymmetry (Manning et al., 1996), changes in soft tissue asymmetry may be perceptible only by those in daily contact with the target, that is, long-term partners (Benshoof & Thornhill, 1979; Scutt & Manning, 1996). Future research should include long-term partners as well as unknown females in the sex-categorization task in order to investigate this hypothesis.

That similar effects emerged for normally ovulating women and women on the pill is interesting. Menstruation/bleeding occurs not only as a function of the natural hormonal shifts that occur across phases of the menstrual cycle but also as a consequence of drugs that mimic these hormonal shifts. As such, menstruation is no longer a reliable marker of *current* female fecundity (Temkin, 1991), as fecundity, but not "menstruation," may be temporarily suspended through the use of a contraceptive pill. In our study, the responses of males did not differentiate between these two causes of menstruation. As a distal cue, "menstruation" as a sign of fecundity may still be very relevant to men, even if fertility is temporarily suspended through use of a contraceptive pill. Although used for a variety of reasons, the contraceptive pill is mainly used by fertile women to temporarily suspend that fertility. Accordingly, "menstruation" indicates the long-term potential reproductive capacity of a woman, even if she is using a contraceptive pill, and hence is an important cue for males to be sensitive to.

Despite the relatively low reproductive pressures on males, we have demonstrated that female fertility levels influence the speed with which they identified the sex of female targets. Thus, the same fundamental biological factors (i.e. fluctuating hormonal levels in females) that influence sex-categorization in female perceivers also play an important role when male perceivers are considered.

In addition to characteristics of the perceivers themselves, we have also demonstrated that characteristics of the targets of perception can modulate the efficiency with which sex-based categorizations are made.

## CONCLUSIONS

Our program of research has demonstrated that perception of the face is not a fixed process, but rather can be influenced by a variety of biological and social (motivational) factors. Identification of the sex of strangers from facial information has been considered a fundamental process in person perception, occurring rapidly and spontaneously (Stangor et al., 1992). We have demonstrated, however, that the efficiency of such sex-based categorization – both the speed at which sex is accurately identified (Brinsmead-Stockham et al., 2008; Johnston et al., 2003, 2005; Macrae et al., 2002) and the error rate (Johnston et al., 2009) – is influenced by biological and motivational factors. Taken together, the results of our research program demonstrate the complexity of the person perception process. Rapid and accurate perception of the sex of another is influenced by biological factors associated with both the perceiver and the target (Johnston et al., 2003, 2005; Macrae et al., 2002), by the needs and intentions of the perceiver (Brinsmead-Stockham et al., 2008; Johnston et al., 2003), and by specific facial features of the target (Johnston et al., 2009). To fully understand the process of sex-based categorization, researchers must consider features of both the perceiver and the target of that perception.

Although our research has demonstrated the malleability of the perception of the sex of others, further research is needed to better understand the processes underlying the systematic variations in the efficiency of sex-based categorization. For example, do women identify sex-based features of the face in times of high fertility more effectively, or do they simply show greater attention to such features at such times? Are there individual differences in the effects of these hormonal and motivational factors on the identification of the sex of others? And, importantly, what are the consequences for the fertility-linked effects we have described above?

Perception of visual information from the face does not always proceed in the same manner. To fully understand how the perceiver comes to identify the sex of strangers, researchers must not only consider the features of the face that specify maleness, or femaleness, and the sensitivity of perceivers to this information, but must also account for the additional factors, both biological and social, that are known to impact on sex-based categorization.

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# Section II

# Neuroscience and the Social Psychology of Visual Perception

# 6

# Affect as a Source of Visual Attention

MARIANN WEIERICH and LISA FELDMAN BARRETT

Affect is a source of visual attention. Psychologists have made a distinction between "affect" and "cognition," suggesting that the latter operates to guide the organism whereas the former is merely a response. We suggest that this distinction is somewhat artificial and based on unnecessarily rigid conceptualizations, and that, when considering the role of affect in visual attentional processing, affect instead constitutes a source of attention. In the current chapter we will first define affect and attention and outline their neural circuitry. We will then discuss the functional consequences of affect as a source of attention, including the implications for pre-attentive processing, awareness, and attentional control.

## AFFECT

Affect is any state that represents how an object or situation impacts a person. At its most basic, "core affect" refers to a psychologically primitive state that can be described by two psychological properties: hedonic valence (i.e., degree of pleasure/displeasure) and degree of arousal (i.e., physiological activation). In other words, when people experience affect, they experience a unified physiological, or somatovisceral, state that can be described in terms of how pleasant or unpleasant it is, and how much physiological activation is experienced in the moment (e.g., Barrett & Bar, 2009). Thus when a person suddenly encounters a very disgusting object, such as a dead rat, that person likely would describe his or her resulting internal state as unpleasant and highly arousing, or physiologically activating. Similarly, seeing pretty flowers might result in a state that can be described as pleasant but low arousal (i.e., not much physiological activation despite the hedonic pleasure). Human responses to all objects and events in the world can thus be described along these two continua, from pleasant to unpleasant, and from no arousal to high arousal.

Core affect refers to a person's current unified internal state. Although it can be described using the properties of arousal and valence, core affect itself is the sum total of a person's internal hedonic and somatovisceral state. Core affect thus is also quite changeable, and essentially is a running representation of the moment-to-moment changes in a person's neurophysiological and somatovisceral state in response to the continual flow of changing events in the world (Barrett, 2006; Russell, 2003; Russell & Barrett, 1999). In this way, core affect constitutes a neurophysiologic barometer of a person's relationship to the environment at a given point in time. When an object or event causes a change in a person's core affect, we say that the person has an affective response to that object or event. Such changes in core affect are the means by which information about external objects and events is translated into an internal code or representation (Damasio, 1999; Nauta, 1971; Ongur & Price, 2000), and these changes have implications for subsequent behavior. Social psychology is concerned with the patterns of people's responses to social objects and events; core affect and changes in core affect are central to these investigations.

It is important to note that objects and events themselves are not inherently affective. Rather, what we call "affective objects" (e.g., positive things, negative things) are objects that have acquired affective meaning by their association with some degree of pleasantness or unpleasantness and some degree of arousal in a given person's experience. For example, for many people, chocolate has acquired positive, arousing value due to repeated pleasant encounters. However, for people who do not particularly like chocolate (i.e., they do not feel especially pleasant when eating chocolate), it can acquire neutral, non-arousing value. Further, iterative encounters with a given object or class of objects also can influence the affective meaning of that object or class of objects; people respond differently when an object is novel (or fairly novel) compared to when the object is familiar. Finally, the affective value of a given object or event for a given person also can be a moving target over time; in some contexts (e.g., the first snow of the season) an object (i.e., snow) might have positive and arousing value for a person, whereas in other contexts (e.g., snow in April) the same object might have negative and arousing value for the same person. In the current chapter, when we refer to "affective value", we thus refer to the meaning that has been acquired by an object or class of objects through experience.

## NEURAL CIRCUITRY OF AFFECT

We have noted that the primary function of core affect is to translate sensory information from the external environment into meaningful internal representations that can be used to guide behavior in the world. A widely distributed circuitry accomplishes this function by binding external sensory and internal somatovisceral information to create a mental representation of external objects, or to link sensory information about a stimulus with a representation of how the stimulus has affected the person's internal state in the past (Barbas, Saha, Rempel-Clower, & Ghashghaei, 2003; Ghashghaei & Barbas, 2002; Kringelbach & Rolls, 2004; Ongur, Ferry & Price, 2003; Ongur & Price, 2000). The broad neural circuitry underlying affect includes subcortical and cortical areas. Subcortically, the circuitry includes regions that are traditionally considered to be affective, such as the amygdala and ventral striatum. These areas in the limbic system, which are among the most primitive parts of the brain, traditionally have been considered affective. However, affective circuitry also includes higher cortical areas including anterior portions of the cortex that have traditionally been considered to be cognitive, including the orbitofrontal cortex (OFC), broader ventromedial prefrontal cortex (vmPFC), and anterior cingulate cortex (ACC). These subcortical and cortical areas communicate with each other via continual feedback loops. For example, parts of the brain that have traditionally been considered to be cognitive regulate affective states after they have been established, and also participate in instantiating affective states (e.g., Barrett & Bar, 2009; Duncan & Barrett, 2007).

Within the larger circuitry of affect (see Figure 6.1), two interrelated functional sub-circuits make up a ventral system for core affect (cf., Carmichael & Price, 1996; Elliott Friston, & Dolan, 2000; Ongur & Price, 2000). The first functional circuit creates a neural representation of an object that includes both external sensory features of the object and information about the impact of that object on the current state of the body (Craig, 2002). This circuit involves connections between the basolateral complex (BL) of the amygdala and the central and lateral portions of the orbitofrontal cortex (OFC). The BL directs the organism to learn more about a stimulus so as to better determine its predictive value for well-being and survival (Davis & Whalen, 2001; Kim, Somerville, Johnstone, Alexander, & Whalen, 2003; Whalen, 1998). The OFC is necessary for the mental representation of an object's value in a given context (Dolan & Morris, 2000; Elliott et al., 2000; Kringelbach, 2005; Kringelbach & Rolls, 2004). Both the BL complex and the

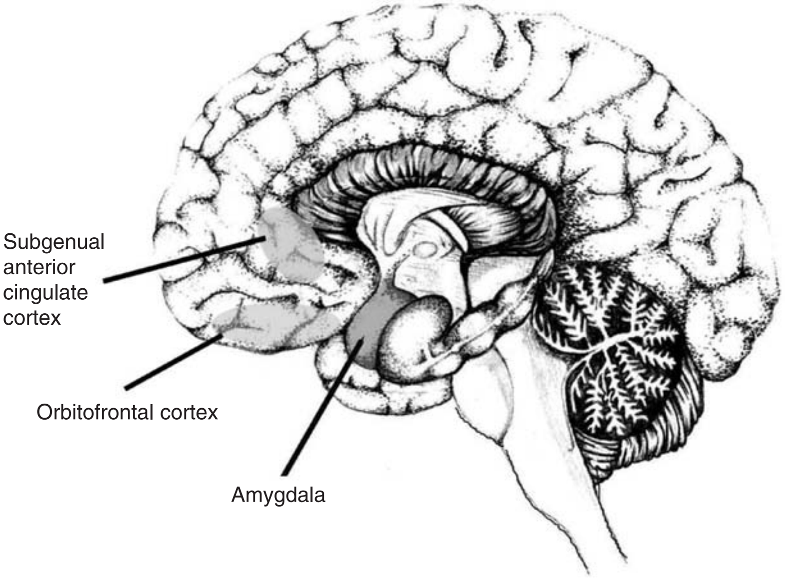

FIGURE 6.1 Right hemisphere medial view of the primary neural circuitry underlying affective processing. The amygdala, orbitofrontal cortex, and subgenual cingulate cortex communicate via iterative feedback loops to integrate past experience with affective objects with current core affect.

lateral OFC have robust, reciprocal connections with cortical representations of all sensory modalities (Ghashghaei & Barbas, 2002; Kringelbach & Rolls, 2004; McDonald, 1998; Stefanacci & Amaral, 2002); these areas communicate back and forth to form a functional circuit for the integration of sensory information. When a person encounters a specific object or event, this circuit incorporates information about the stimulus with prior sensory representations of the same object or event to help direct subsequent action. Recent evidence suggests that as the basolateral complex computes the predictive value of a stimulus (i.e., likelihood that the stimulus fits the prior experience of similar stimuli), the orbitofrontal cortex participates in generating a response based on that prediction (Holland & Gallagher, 2004).

The second functional circuit within the larger circuitry of affect coordinates neural representations that guide visceromotor control, or the internal regulation of affective responses to objects or events. This circuit includes reciprocal connections between the vmPFC, the subgenual ACC, and the amygdala. This network modulates the visceromotor (i.e., affective) responses that have become associated with an object (Koski & Paus, 2000). In particular, the vmPFC may help link sensory representations of stimuli and their associated visceromotor (i.e., core affective) outcomes. The output of this second circuit then informs the computation of affective value by the first circuit: the BL and lateral OFC. This notion is supported by evidence that the vmPFC, and in particular the medial sector of the OFC, is important for altering simple stimulus–reinforcer associations via extinction (Milad et al., 2005; Phelps, Ling, & Carrasco, 2004; Quirk, Russo, Barron, & Lebron, 2000), and is activated by representations of the current internal sensory state (Hurliman, Nagode, & Pardo, 2005) more generally.

In general, the OFC and vmPFC serve as crucial components of a system that (1) binds sensory information from outside the body with sensory information from inside the body and (2) guides appropriate responses to external objects. In other words, when people encounter objects that have acquired affective meaning, the OFC and vmPFC integrate incoming featural information (e.g., the legs on a spider) with the internal affective responses that are guided in part by prior experience with those features (e.g., current affective response to a spider informed by past affective response to a spider) to determine subsequent action. Importantly, these brain areas communicate with the sensory cortices through the amygdala, thereby influencing sensory areas in an iterative fashion (i.e., repeatedly refining the person's experience of particular objects). Given the reciprocal connections and multiple iterations, although it is difficult to derive definitive causal relations between sensory and affective processing, core affect certainly influences how information about external objects is processed.

The affective response to an object is dependent on the detection of and attention to that object. Although detection of objects can be realized through any sensory modality, most seeing people use vision to select many affective stimuli in the world. We suggest that not only is the efficiency of visual selection of an object or location influenced by affective value, but also that affective value can be a source, or driver, of visual attention. We will discuss the ways in which people select visual information and the manner in which affect plays a significant role.

## VISUAL ATTENTION

Attention is a general term for any cognitive operation that results in the selection of some information over other information. Selective attention is critical for intelligent behavior within the complex tasks and environments in the world. Almost any action requires selection of some sort, because the world is full of objects, agents, and potential actions that compete for processing priority. Selective attention operates in vision, audition, categorization, memory, response selection, and motor control (see Pashler, 1998), although we will restrict our focus to visual attention.

"Attention" as a general term can be misleading, as people tend to think that all mentions of "attention" refer to the same process. In fact, attention is not a unitary construct and, in the course of isolating relevant mechanisms of visual attention for discussion, it is important to understand how attention researchers distinguish between those mechanisms. There are several important functional and system-level distinctions that guide our examination of affect as a source of attention.

### *Overt Attention*

Vision is inherently selective, because the human retina does not have uniform sensitivity across the visual field. High-resolution visual processing is limited to a small, central region of the retina (the fovea) that covers only about 2° of visual angle. To obtain high-resolution information from individual objects, we make *saccades* (i.e., shifts of the eyes) to bring the features of objects onto the fovea. We make approximately three saccades each second (Henderson & Hollingworth, 1998; Rayner, 1998), resulting in hundreds of thousands of eye movements each day. Periods of relative stability between saccades are called *fixations*, and each fixation lasts approximately 300 ms (Henderson & Hollingworth, 1998). Vision – seeing what is in our visual field – occurs during these stable fixations.

Eye movements allow the acquisition of high-resolution visual information, and they also have another function. Intelligent behavior requires the ability to specify objects in the world and keep track of them. This pointing function supports everyday activities, as gaze position is tightly linked to motor actions (Hayhoe, 2000; Land, Mennie, & Rusted, 1999). Thus, gaze fixation specifies objects as the targets of action, connecting visual perceptual information with internal motor programs and other cognitive operations (Ballard et al., 1997). Eye movements are the principal means by which goal-relevant objects are selected for further perceptual processing, recognition, and action. A sequence of eye movements unfolds over the timecourse of multiple seconds of viewing, providing a continuous window on the perceptual operations supporting behavior.

### *Covert Attention*

Although we attend by moving the eyes to fixate objects, we also can attend to objects without eye movements. This mechanism is termed *covert visual attention* (as opposed to *overt* eye movements). During a fixation, the visual system can select a particular region of the visual field for more extensive processing. Covert attention has been demonstrated in cueing studies (Posner, Snyder, & Davidson, 1980).With the eyes kept still, participants were cued to a particular region of space where a simple target (e.g., a dot) was likely to appear. Detection of the target was faster at the cued location, demonstrating facilitated perceptual processing at the attended region. Covert attention can be conceptualized as an internal mechanism that can be directed to increase visual sensitivity.

Covert attention has been decomposed into three sub-mechanisms: shift, engage, and disengage (Posner et al., 1980). The transfer of attention to a new location requires that attention first is *disengaged* from the current location, then *shifted* and *engaged* at the new location. The shift and engage components both refer to the orienting of attention to a new object or location, and they may not reflect distinct cognitive operations. We use "orienting" or "shifting" attention to refer to the entire process of directing attention to a new object or location. Unlike sequences of eye movements, which typically unfold over multiple seconds of viewing, covert attentional shifts can operate on a much faster timescale, with shifts of attention sometimes requiring only 50–100 ms (e.g., Müller & Rabbit, 1989).

### *Object Perception*

We have been outlining mechanisms of the spatial allocation, or shifting, of visual attention. We have noted that location-based attention provides a critical navigational role in daily life, as it enables efficient and adaptive selection and tracking of potentially important objects and areas. It is also important to recognize the role of object-based attention, which refers to the manner in which people's brains bind, or assemble, features into coherent objects (e.g., Scholl, 2001). Without such binding, there would be no coherent targets for spatial shifts of attention, and vision would be inherently less efficient. There is some debate as to whether the brain recognizes objects, rather than simply detecting them, before attention is directed to them. Some argue that as soon as a person knows that an object exists in a given spatial location (via covert attention), the person also knows the object's identity (e.g., Grill-Spector & Kanwisher, 2005). According to this view, detection of the presence of an object in the environment occurs simultaneously with recognition of the object: "seeing" a small irregular shape on a table in the periphery means that the person also knows that the object is a key, for example. Although some would argue that a novel object in the periphery cannot be recognized (i.e., presence can be detected, but the person cannot know what the object is), proponents of this view would assert that the novel object is recognized as a coherent object prior to attention even when the object cannot be specifically identified. According to the opposing view, a person can know that an object is in a location without knowing what it is (e.g. Mack, Gauthier, Sadr, & Palmieri, 2008); as is observed with attentional capture, features of the object such as a difference in contrast or luminance can attract attention without prior recognition.

With respect to the current chapter, we note only that visual sensitivity can be enhanced for threat objects (e.g., high arousal, negative). Using the rapid serial visual presentation (RSVP) paradigm, for example, several studies have shown that threat stimuli, but not neutral stimuli, can be detected in a stream of rapidly presented stimuli, even during a period in which the visual system has been shown to have relatively low perceptual sensitivity (e.g., Anderson & Phelps, 2001). These data support the notion that affective value enhances visual sensitivity. In general, we suggest that the affective value of objects sensitizes the brain for perceiving those objects. People therefore are more likely to have their attention captured by stimuli that they have learned are highly activating and positive (e.g., erotic images) or negative (e.g., weapon) than by neutral stimuli. The features of such affective stimuli are more efficiently recognized as coherent objects, and the brain can prepare responses to them more quickly. Affect, just as luminance changes or sudden onsets, can drive attention.

## NEURAL CIRCUITRY OF ATTENTION

Two neural pathways have been proposed as the circuitry by which people process visual information: the ventral visual processing stream and the dorsal visual processing stream (see Figure 6.2). The ventral, or "what" stream, is implicated in object-based processing of stimuli, whereas the dorsal, or "where" stream, is

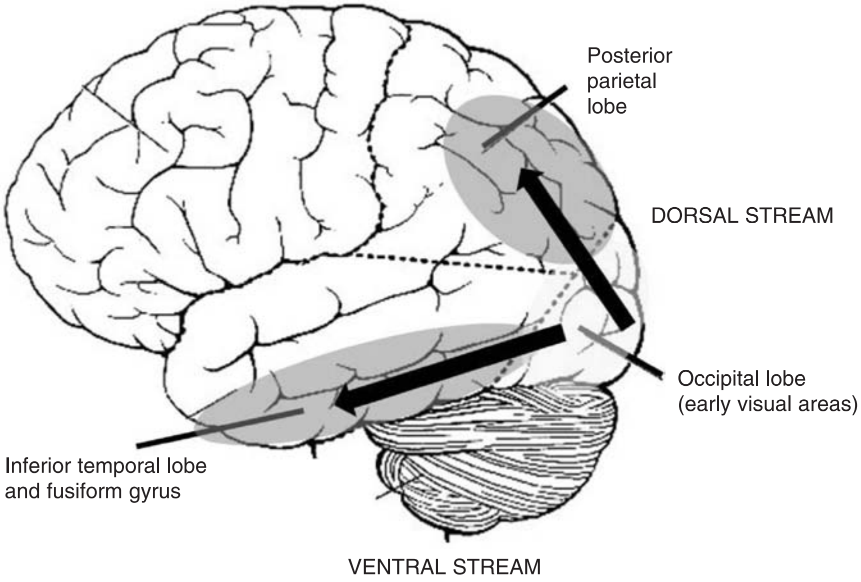

FIGURE 6.2 Left hemisphere lateral view of the primary neural circuitry underlying visual processing. The dorsal (occipital cortex through posterior parietal cortex and on to premotor areas) and ventral (occipital areas through the temporal lobe and fusiform gyrus) streams are connected to the anterior cingulate (not visible in this lateral view). The amygdala enhances visual processing of affective stimuli.

thought to be the locus of spatial processing (e.g., Goodale & Milner, 1982; Ungerleider & Mishkin, 1982). Both streams begin with primary visual area V1 in the occipital lobe and projections feed forward along each path. Considerable debate continues as to the degree of independence or interaction of the dorsal and ventral pathways in perception and subsequent action. For the purpose of the current chapter, we simply outline the circuitry of both as they relate to attention to affective stimuli. "What" and "where" both are potentially socially relevant: recognition of a facial expression or other affective object and direction of attention to potentially important social objects both allow people to operate more effectively in the world. The affective meaning of objects could facilitate more efficient processing along either pathway, resulting in more efficient spatial allocation of visual attention to affective objects as well as more efficient recognition of those objects.

## *Neural Basis of Spatial Shifts of Attention*

The neural circuitry underlying spatial shifts of attention follows a pattern of dorsal activation; information is encoded in early visual cortex (V1) and transitions forward into the parietal cortex in preparation for action. More specifically, in addition to the occipital cortex, this network includes posterior parietal cortex, which contributes a sensorimotor representation of the object in space, dorsolateral premotor cortex, which prepares responsive movement (e.g., eye movement after covert shifts), and the anterior cingulate, which helps compute relevance (Gitelman et al., 1999). A considerable literature indicates that covert and overt shifts of attention utilize very similar neural circuitry, and that non-overlapping areas or extents generally are attributable to greater activity required for saccades or differences in task demands between studies (e.g., Corbetta et al., 1998; de Haan, Morgan, & Rorden, 2008; Gitelman et al., 1999; Nobre, Gitelman, Dias, & Mesulam, 2000). This circuitry also overlaps with the affective subcircuits discussed earlier; the affective subcircuit that coordinates internal and external sensory information includes the anterior cingulate cortex, and the subcircuit that prepares the system for action based on affective value includes the premotor areas. Facilitated neural processing of objects in these regions due to affective meaning would allow more efficiently directed spatial allocation of attention. So, for example, visual attention might be directed more rapidly to the location of a person than to a piece of furniture.

Some suggest that spatial shifts of attention serve as a "spotlight" or "zoom lens" by which the central focus of attention receives greater neural input while more peripheral information receives less processing. Recent functional magnetic resonance imaging (fMRI) evidence shows that when attention is deployed over a wider area, neural activation in visual areas is diffused across early and later areas (e.g., V1–V4; Mueller, Bartelt, Donner, Villringer, & Brandt, 2003). Whereas a larger proportion of visual cortex was active when attention spanned a large surface area, percent signal change in the fMRI signal within all four visual cortical areas decreased with the greater visual range. This suggests then that as attention increased in span, fewer processing resources were allocated per square unit of visual cortex. This evidence supports the notion that unattended information within a spatial visual extent receives some neural processing, but less than attended information. To the degree that the affective value of stimuli can facilitate a more focused spatial shift of attention, a smaller spatial range will allow the availability of more neural resources for processing affective information. Thus, for example, the covert or overt shift of attention to the location of a coiled object (e.g., a snake percept) is likely to be more focused, and thus have more neural activity, than a shift of attention to a non-snakelike object, for which the shift of attention might encompass greater visual area.

## *Neural Basis of Object Perception*

Neurally, consistent with the notion of the "what" stream, object recognition is associated with areas in the ventral visual stream. In particular, object perception has been localized to the occipitotemporal cortex, reflecting the interaction of encoding in visual areas with memory processes in the temporal cortex. In addition, the lateral occipital cortex (LOC) has been shown to respond to the shape of objects rather than low-level features, and this area also is associated with behavioral recognition tasks (e.g., Grill-Spector et al., 1998). Most recently, studies have shown that enhanced learning of categories enhances specificity in sub-areas of the inferior temporal (IT) cortex (Grill-Spector, 2003), and that object categories also activate different sub-areas of IT (Bell, Hadj-Bouziane, Frihauf, Tootell, & Ungerleider, 2009). Part of the function of IT is to help recruit memory functions supporting the identification of objects as belonging to a class of objects. IT more generally also is thought to be the terminus of the ventral stream, although we note that projections travel in both directions. Thus objects that have been encountered before have representations in temporal areas that are retrieved for recognition. Affective objects, and especially those for which initial responses were high in arousal and valence (e.g., snakes), are more likely to have strong representations in the temporal memory areas.

The centerpiece of the circuitry underlying *affective* object recognition is the OFC (Barrett & Bar, 2009). As discussed earlier in the discussion of affective circuitry, the OFC integrates internal and external sensory input to create a contextually sensitive representation of the world and its value to the person at a particular moment in time (Mesulam, 2000). The OFC plays a role in representing reward and threat (e.g., Kringelbach & Rolls, 2004) as well as hedonic experience (Kringelbach, 2005; Wager et al., 2008), and it also plays a role in processing olfactory, auditory, and visual information (Kringelbach, 2005; Price, 2007). The OFC's ongoing integration of sensory information from the external world with sensory information from the body suggests that conscious percepts are indeed intrinsically infused with affective value, such that the affective salience or significance of an object is not computed after the fact. Thus the OFC plays a crucial role in forming the predictions that support object perception. This suggests that the predictions generated during object perception carry affective value as a necessary and normal part of visual experience. In this way, the ventral "what" stream also is strongly influenced by affective meaning such that objects with social relevance might be more likely to be recognized with minimal effort compared to non-social objects.

Affect can facilitate both of the most common mechanisms that determine what we see in the world. Affect can be a source for direction of attention in space to objects that are socially important, such as other people, animals, or inanimate objects that have meaning based on prior experience. Affect also can be a source of more efficient object recognition; the visual system can more rapidly bind the features of objects with affective meaning in order to prepare a person to act.

## AFFECT PERFORMS ATTENTIONAL FUNCTIONS

Core affect modulates sensory processing. In particular, the role of the amygdala in sensory processing is well delineated and we will focus on that structure. The amygdala, which is the centerpiece of the interconnected affective circuitry discussed earlier, modulates sensory processing in three ways (Duncan & Barrett, 2007). First, the amygdala can indirectly influence sensory processing through a top-down form of attention involving the dorsolateral prefrontal cortex (via connections with the OFC) in a goal-directed way (cf. Ochsner & Gross, 2005). Second, the amygdala can directly enhance stimulus-driven sensory processing via strong reciprocal connections with unimodal sensory areas, such as visual cortex. Third, the amygdala can engage in a bottom-up form of attention modulation, entraining all sensory cortical areas to select between competing sensory representations. We discuss the psychological consequences of these last two circuits, as they illustrate how sensory processing is based on the state of the organism, or core affect.

### *Direct Modulation of Sensory Processing*

The amygdala influences visual processing in a very direct manner by modulating the intensity of neural firing throughout the ventral visual stream (Amaral, Behniea, & Kelly, 2003; Amaral & Price, 1984; Freese & Amaral, 2005). The amygdala facilitates associative connections between affective value and basic visual features of the environment, particularly in the earliest visual areas (i.e., V1). The amygdala also enhances the visual awareness of objects that have been deemed to have affective value (e.g., facial expressions that depict prototypical emotions such as fear) by modulating activity in the more anterior aspects of the ventral stream. Given the amygdala's extensive connectivity to all sensory cortices, we expect that this modulatory role also exists for the affective impact on other sensory modalities. Such enhanced awareness is one way in which affect drives attention.

The amygdala appears to be important for developing associations between affective value and primitive features of the visual world. The primary visual cortex (V1) receives strong, excitatory projections from the basal nucleus of the amygdala. These excitatory neurons from the amygdala project to the types of cells in V1 that are found in neurons involved in associative learning (Freese & Amaral, 2006). Relatedly, neuroimaging data also have shown increased activation around the V1/V2 boundary in response to affectively evocative (compared to neutral) stimuli (Moll et al., 2002). More specific evidence for affective modulation of V1 activity comes from a study using event-related potentials (ERPs) to classically conditioned images. Black and white gratings previously paired with affectively evocative images (i.e. IAPS images) elicited higher amplitude ERPs recorded over primary visual cortex than gratings that were not paired with images (Stolarova, Keil, & Moratti, 2006). The increased conditioned ERP amplitude over V1 occurred roughly 50 ms post-stimulus onset, which is well before information would have time to reach core affective circuitry and loop back to V1. As a result, it is possible that over time this V1 activity becomes amygdala-independent, suggesting that associative, affective learning occurs not only in the amygdala, but in sensory cortex as well. As the activity in V1 eventually gains independence from core affective circuitry, the distinction between affective and non-affective processing in the brain becomes further blurred.

The amygdala also appears to modulate the extent of visual processing. Neuroimaging studies consistently demonstrate that aversive images produce greater activity in the amygdala and throughout the entire visual cortex than neutral images (e.g., Breiter et al., 1996; Lane, Chua, & Dolan, 1999; Lang et al., 1998; Moll et al., 2002; Morris et al., 1998; Taylor, Liberzon, & Koeppe, 2000), as do novel compared to familiar images, and high arousal compared to lower arousal images (Weierich, Wright, Negreira, Dickerson, & Barrett, 2010). Such enhanced activity in the visual cortex appears to be related to enhanced awareness of objects. Objective awareness of valenced stimuli (i.e., greater perceptual sensitivity in signal detection tasks, even when participants report no conscious awareness of the stimulus) is associated with increased amygdala activation, and the absence of objective awareness is associated with no increase in amygdala activation over baseline levels (Pessoa, Japee, Sturman, & Ungerleider, 2006). Furthermore, increased amygdala activation co-occurs with increased activation in the fusiform gyrus (FG); a portion of the brain involved in complex object recognition that is activated when objects reach visual awareness (Bar et al., 2001; Tong, Nakayama, Vaughan, & Kanwisher, 1998), but only when people are objectively aware of the stimuli (i.e., faces) (Pessoa et al., 2006). Greater amygdala and FG co-activation is observed when participants are instructed to attend to faces as opposed to a concurrent distractor (e.g., houses) (Anderson, Christoff, Panitz, De Rosa, & Gabrieli, 2003; Pessoa, McKenna, Gutierrez, & Ungerleider, 2002b; Vuilleumier, Armony, Driver, & Dolan, 2001), and in binocular rivalry studies where a house is presented to one eye, and a facial expression presented to the other, FG activity increases in the hemisphere corresponding to the dominant visual field (i.e., the eye whose sensory input reaches conscious awareness). These correlational findings are consistent with neuropsychological evidence showing that patients with amygdala lesions show a decreased FG response to facial expressions depicting fear (Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004). Thus the amygdala serves as an initial gateway through which percepts, and in particular those with social relevance, reach visual awareness.

Preliminary evidence from our own lab suggests that affective experience can lead to the same enhanced awareness of objects that is associated with increased amygdala and FG activation. Using the signal detection approach employed by Pessoa and colleagues (Pessoa et al., 2006), we have found that individuals who characterize themselves as introverted (and who report decreased levels of positive affect; Lucas & Baird, 2004) demonstrate greater perceptual sensitivity to briefly presented (16 ms) faces depicting fear than those who are lower in introversion (Duncan & Barrett, unpublished data). In addition, we have shown that faces previously paired with negative information were perceived for longer durations in a binocular rivalry task compared to faces paired with neutral or positive information, indicating maintained awareness of these stimuli (Anderson, Bliss-Moreau, & Barrett, submitted). These findings support the idea that what people literally see in the world around them may in part be determined by their core affective state (e.g., Phelps et al., 2006).

### *Bottom-up Modulation of Sensory Processing*

The circuitry that computes core affect also plays an integral role in regulating sensory processing via its projections to the brainstem and basal forebrain, two parts of the brain that are necessary for consciousness. This modulation can occur in two ways. First, brainstem and basal forebrain nuclei modulate the connections between thalamus and cortex (cortico-thalamic circuits) that are partly responsible for forming and selecting the groups of neurons that fire together to form conscious percepts (objects that people are aware of seeing). Second, brainstem and basal forebrain nuclei communicate unidirectionally to the cortical mantle, and these projections act as a “leaky garden hose” (Edelman, 2004, p. 25) that controls the degree of neuronal firing. Importantly, the core affective circuitry (e.g., amygdala, vmPFC, and ventral striatum) provides the only path by which sensory information from the outside world reaches the brainstem and basal forebrain (Mesulam, 2000). In these ways, areas involved with establishing a core affective state indirectly constrain processing throughout the rest of the cortex; they select assemblies of neurons that maximize reward or minimize threat, in turn influencing which contents are experienced in the moment, and which are more likely to be stored in long-term memory (Edelman, 2004; Edelman & Tononi, 2000). Thus not only does the current state of the person interact with the environment to influence what is seen (e.g., objects experienced as extremely negative, positive, or highly arousing), but it also influences what is encoded most strongly into memory and is thus more likely to inform future predictions about the same objects or class of objects.

## FUNCTIONAL CONSEQUENCES OF AFFECT AS A SOURCE OF ATTENTION

There are important psychological and phenomenological consequences arising from the indirect modulation of cortical activity by affective circuitry. First, core affective circuitry helps to select the information that reaches conscious awareness by directing the formation and maintenance of the neuronal assemblies that underlie conscious experience. Therefore, along with more deliberate top-down forms of attention (from lateral prefrontal areas) and bottom-up forms of stimulation from the sensory world, core affect helps to orchestrate the binding of sensory information into a single, unified conscious field. Second, via multiple iterations of processing, the external sensory information that drives brainstem and basal forebrain activity becomes processed with and bound to somatovisceral information. As a result, control of attentional allocation to conscious percepts of the external world is greatly influenced by affect.

## *Pre-attentive Processing and Awareness*

The nature of visual processing in the absence of attention is the subject of ongoing debate between early and late selection theories of attention (Broadbent, 1958; Deutsch & Deutsch, 1963; Treisman & Gelade, 1980). The former claims that selection occurs fairly early in vision, such that unattended objects are not processed beyond early perceptual analysis and therefore are not identified. The latter claims that all visible objects are processed to the level of meaning prior to selection; the object with the most salient or pertinent meaning is then selected. Although selection can occur at multiple levels in the visual system (Luck, Woodman, & Vogel, 2000), most evidence suggests that, consistent with early selection theories, objects that do not receive perceptual-level attention are not processed to the level of meaning. When the spatial distribution of attention is limited to a centrally presented object, the meanings of other visual objects are not activated (Lachter, Forster, & Ruthruff, 2004; Lavie, 1995). Even highly familiar and personally relevant objects, such as one's name, do not appear to be identified when attention is exclusively directed elsewhere (Harris & Pashler, 2004).

The issue of whether affective, personally relevant stimuli are identified without attention has been a topic of recent research in the literature on anxiety and attention. The strongest potential evidence for preattentive processing of threat-relevance comes from the visual search experiments of Ohman Flykt, and Esteves (2001a). The time necessary to find spiders among neutral stimuli was independent of set size (i.e., spiders were found to "pop out" of the display), suggesting pre-attentive processing of threat-relevant objects. However, Lipp and colleagues (Lipp et al., 2004) found no advantage for individuals high in snake or spider fear. In a second study with participants unselected for fear status, they found highly efficient search not only for spiders but also for other animals that pose no threat, casting into doubt special pre-attentive processing of threat. In addition, Cave and Batty (2006) have argued that search in the Ohman et al. study was driven by perceptual-level differences between spiders and distractor stimuli rather than by differences in meaning and threat. Thus the behavioral evidence, although not conclusive, suggests that threat-relevant information is not processed pre-attentively.

Neuroimaging research has offered additional insight into the potential pre-attentive attentional processing of affective stimuli. This work generally focuses on the response to threat (i.e., high-arousal negative) stimuli. Researchers continue to debate whether threat information, as high-intensity affective information, can be detected without attention (e.g.,Vuilleumier et al., 2001), or whether even minimal attentional resources are required for threat detection (e.g., Anderson et al., 2003; Bishop, Duncan, Brett, & Lawrence, 2004a; Okon-Singer, Tzelgov, & Henik, 2007; Pessoa et al., 2002b). The most recent findings suggest that some degree of attention is required for amygdala activation (e.g., Pessoa et al., 2006). When a central task requires all available attentional resources, no amygdala activation to task-irrelevant threat information is observed (e.g., Bishop, Jenkins, & Lawrence, 2007; Pessoa et al., 2006). Processing of threat appears to be voluntary in the sense that top-down goals (e.g., searching for spiders or avoiding looking at spiders) strongly influence perceptual interaction with anxiety-related stimuli. Threat processing is certainly available to consciousness, and threat processing requires some attentional capacity. There also are likely to be individual differences in the degree of attentional resources required to identify threat-relevant (or other affective) stimuli. For example, clinically, individuals with spider phobia might require fewer attentional resources than non-phobics to detect the presence of a spider, consistent with the non-clinical finding that familiar words (such as one's name) require fewer attentional resources for identification than non-primed words (Treisman, 1960).

## *Control of Attentional Allocation*

The effects of attention on perception and memory are substantial. Individual differences in where and when attention is directed to visual stimuli will largely determine differences in what people perceive, remember, and act upon. To understand how affect influences the targets of attention, it is important to understand the basic factors that control where attention is directed. The allocation of covert attention and the overt movement of the eyes both are controlled by an interaction between top-down, goal-directed mechanisms and low-level, stimulus-driven mechanisms (e.g., Desimone & Duncan, 1995). In individuals experiencing high arousal, for example, the balance between the top-down tendency to select affective information and the bottom-up, low-level features of affective stimuli may be disrupted, such that control over the allocation of attention is diminished, even in the face of task demands (Eysenck & Calvo, 1992; Eysenck, Derakhshan, Santos, & Calvo, 2007).

A fundamental problem for the visual system is to decide which locations or objects deserve priority. Often priority is goal-dependent. In addition, we generally have the ability to exert control over where the eyes are directed (e.g., averting gaze from an angry face) and where covert attention is directed (e.g., monitoring someone out of the corner of one's eye). In addition, real-world knowledge can control the allocation of attention; when searching for an object in a scene, people rapidly direct attention to locations known to contain that type of object (Torralba, Oliva, Castelhano, & Henderson, 2006). Given that we have considerable control over where we attend, monitoring where a person attends provides direct evidence about individual differences in the priority given to particular objects and agents. For example, a top-down bias to avoid negative information can be observed directly by monitoring eye movements (e.g., Calvo & Avero, 2005; Pflugshaupt et al., 2005).

Although top-down goals and knowledge help determine the focus of attention, some visual events attract attention regardless of task; they capture attention (Yantis & Jonides, 1984). Sudden changes in the world (e.g., when an object looms toward a viewer; Franconeri & Simons, 2003) are given high priority regardless of top-down goals. Current evidence suggests that a fairly small set of perceptual events, including the abrupt appearance of an object and object motion (Franconeri & Simons, 2003; Yantis & Jonides, 1984), capture visual attention and the eyes. Such capture is likely to be based on low-level sensory events that signal abrupt change (Franconeri, Hollingworth, & Simons, 2005). It is also possible that object meaning, including affective value, might influence attention capture, and there is currently considerable debate over possible stimulus-driven attention capture by affective stimuli, particularly in psychopathology (Cave & Batty, 2006; Ohman, Lundquist & Esteves, 2001b).

Neuroscientific evidence is mounting for separate systems for top-down and bottom-up processing (e.g., Corbetta & Shulman, 2002), and the current behavioral evidence suggests that people might experience decreased inhibitory control over attention to affective stimuli, which implicates modulation of top-down functioning. Neuroscientists conducting examinations of differential processing of threat in anxious individuals have addressed individual differences in the degree to which anxiety status is associated with the initial amygdala response, as well as the degree to which prefrontal functioning (i.e., executive control) is impaired among anxious participants (e.g., Bishop et al., 2004a; Carlsson et al., 2004). For example, one fMRI study with unselected participants examined the moderating role of self-reported state anxiety in neural responses to threat stimuli, and found that higher state anxiety is associated with reduced recruitment of executive control areas in the presence of task-irrelevant threat stimuli (Bishop, Duncan, & Lawrence, 2004b). Additionally, a positron emission tomography (PET) study revealed that both animal phobic and non-phobic participants exhibited initial amygdala activation in response to threat stimuli; however, this activation persisted in phobic individuals, whereas non-phobic individuals showed subsequent deactivation of amygdala replaced by activation of executive control areas (Carlsson et al., 2004). Data from both studies support the notion that anxious individuals experience decreased cognitive control, or decreased ability to inhibit attentional processing of threat. The evidence also suggests prolonged neural recruitment of the amygdala in response to threat stimuli in anxious individuals or in anxiety states.

Difficulty with inhibition of threat information may be due to problematic conflict monitoring (i.e., processing of discrepancy between task demand and task-irrelevant distractors) and resolution. A recent fMRI study showed that the magnitude of conflict between emotional distractor stimuli and task demand predicted the degree of activation in amygdala and prefrontal areas, whereas the resolution of that conflict was associated with increased activity in anterior cingulate cortex and decreased activation in the amygdala (Etkin, Egner, Peraza, Kandel, & Hirsch, 2006). This finding dovetails with other research showing increased activation in anterior cingulate cortex in response to infrequent threat distractors in all participants; as expectancy of threat cues was established, anxious participants recruited this area less, demonstrating decreased control over threat processing (Bishop, Duncan, Brett, & Lawrence, 2004a).

Additional fMRI research highlights the role of expectancy in the processing of emotional visual information. In an expectancy task in which emotional and neutral pictures were always preceded by accurate expectancy cues (e.g., up arrow for emotional, right arrow for neutral), researchers found increased activation in prefrontal, midbrain, and amygdala regions (Bermpohl et al., 2006). Key to this finding is that increased activation did not occur in response to the expectancy cue itself, but only during subsequent picture presentation. If we conceptualize anticipation as heightened arousal, it also represents a core affective change, which could predispose a person to a more intense response if and when a stimulus is detected.

## CONCLUSION

A tremendous amount of research has now established that attention and object recognition are complex processes that rely on many different sources of information from the world (e.g., contrast, color, texture, low spatial frequency cues). We suggest that attention and object recognition use another source of information: sensory cues from the body that represent the object's value in a particular context. People don't come to know the world exclusively through their senses; rather, their affective states influence the processing of sensory stimulation from the very moment an object is encountered. These ideas suggest that exposure to visual sensations alone is not sufficient for visual experience; an affective reaction is one component of the prediction that helps a person see the object in the first place. Specifically, the brain predicts an object's value for a person's well-being based on prior experiences with that object, and these affective representations shape the person's visual experience. When the brain effortlessly guesses an object's identity, that guess is partially based on how the person feels. Affect therefore is not merely a consequence of attending to hedonically or physiologically evocative information; affect itself is a source of attention.

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# 7

# Through the Lens of Emotion: The Role of the Amygdala in Emotionality, Arousal, and Attention to the Visual World

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*I*magine that you and a colleague have just arrived at a work-related social gathering. As you are scanning the room for food and drink and friendly faces, your colleague swears suddenly in alarm and nudges your elbow. Your eyes widen for a fraction of a second in a fleeting and automatic expression of fear, and zoom in on your boss's face, which is furious and looking your way. You perceive the arrangement of her hair, the flush of her face, even a speck of food on her tooth with vivid clarity, at the same time as you are blind to the room's décor, or the clothing or behavior of other people. Your attention immediately focuses on your boss, and your reasoning processes become fully engaged in ascertaining whether you are the source of that anger.

It is well established that we continuously filter "the wheat from the chaff" of incoming sensory information, selectively allocating attention to what is important to our well-being, and suppressing distracting information. By continuously focusing and refocusing our "attentional spotlight" (Eriksen & Eriksen, 1974; LaBerge, 1983), we prioritize what we process. Research over the past decade has demonstrated that emotion is an important factor in focusing attention. Our own research has contributed to a growing body of evidence suggesting that, from early childhood onward, emotionally arousing stimuli require less attention in initial stages of processing, and subsequently capture and maintain more attentional resources for sustained processing, than neutral stimuli. In recent research, we have also demonstrated that one's emotional state can modulate the extent of perceptual processing in the visual cortex, and that producing emotional facial expressions literally reduces or increases what we take in from the world. Finally, our research has helped to clarify mechanisms by which we preferentially process salient stimuli, and to elucidate the role of the amygdala, a brain region made up of a pair of almond-shaped nuclei tucked underneath the cerebral cortex, in tagging emotionally salient events for further processing by other neural systems. We suggest that, if all the world's a stage, the amygdala shines the emotional spotlight.

Attention is generally viewed as a limited resource (Marois & Ivanoff, 2005) that must be allocated just as physical resources are allocated to facilitate an organism's survival. Indeed, attentional and metabolic resources may be linked, as information capturing attention and awareness should be of sufficient biological importance to also harness metabolic resources (Sokolov, 1963). Such allocation of resources requires integration of incoming information with explicit goals and the ongoing requirements of bodily systems. Indeed, attentional filtering has often been discussed in terms of either "top-down" or "bottom-up" processes. Top-down processes involve a prioritizing of visual information that is shaped by expectations, effortful attentional processes, and explicit goals. For example, in the context of a laboratory experiment, top-down processing might involve holding the task rules in mind and, based on these rules, attending to one type of stimulus while ignoring another. In daily life, top-down processing allows us attend to traffic while driving, ignoring an otherwise interesting conversation or beautiful scenery. It allows us to attend to a boring lecture for the sake of a grade or collegiality rather than more immediately rewarding thoughts of lunch or the attractive person seated nearby.

The term "bottom-up processing" refers to the relatively automatic capture of attention by aspects of stimuli themselves. In the context of our own research, we use the term "bottom-up" to refer to more reflexive processes that are driven by the emotional salience or "motivational grabbiness" of the stimuli. These emotionally driven filtering processes are not all-or-none but rather differentially prioritize the visual information that is most relevant to goals informed by the body's basic, evolutionarily conserved resources for responding to important events (for example, heartrate and stress responses harnessed in the service of fighting, fleeing, or seeking food, drink, or a mate). In a laboratory setting, an image of a gun muzzle or a mutilated body may grab attention, eliciting enhanced visual processing even when task instructions dictate that we ignore it. In daily life the sight of a sandwich when we're hungry or a dazzling smile may capture attention during even the most fascinating lecture. [It should be noted that the term "bottom-up" may be used to refer to different aspects of stimulus salience in different areas of research. Whereas we use the term to refer to *motivationally* compelling qualities of a stimulus, in vision research the term is used to refer to the direction of attention by low-level features of a visual object or scene, such as contrast, brightness, colour, orientation, or movement (Itti & Koch, 2001).]

Finally, top-down and bottom-up processes typically interact with each other, so that strongly salient stimuli can capture attentional resources at the expense of explicit goals, yet explicit goals modulate the capture of attention (Corbetta & Shulman, 2002). Indeed, evidence suggests that processing of even the most basic qualities of a stimulus (orientation, colour, motion) is reduced during inattention (Mack & Rock, 1998; O'Connor, Fukui, Pinsk, & Kastner, 2002), and the most motivationally salient stimulus will require some degree of attention for processing (Pessoa, Kastner, & Ungerleider, 2002).

Our research suggests that the amygdala is a key hub for integration of top-down and bottom-up processes – mediating the interface between the internal state of the organism and the incoming stream of visual information from the world. Positioned near the center of the brain, the amygdala is densely connected with many regions in the cerebral cortex, including sensory regions mediating distinct aspects of visual processing (processing of contour, brightness, motion, and shape, as well as categorical recognition of objects, faces and places) as well as frontal lobe regions implicated in evaluating the motivational importance of an event in light of past experiences (Amaral, Behniea, & Kelly, 2003; Young, Scannell, Burns, & Blakemore, 1994). It is also connected to older brain regions, such as the hypothalamus and brainstem, which are central to such somatic processes as heart rate, breathing, and hormone production. Consistent with the proposed role of the amygdala in arousal and attentional orienting in rodent models (Cain, Kapp, & Puryear, 2002; Davis & Whalen, 2001), recent human evidence indicates that the amygdala is essential to alteration of attention associated with emotional arousal. Such attentional allocation in turn enhances the perceptual processing of emotionally significant events.

In this chapter we will first review our contribution to current understanding of bottom-up processes thought to underlie "motivated attention," or the enhancement of visual processing of emotionally salient stimuli, as well as individual and developmental differences in perceptual biases that heighten processing of specific types of stimuli. We will then review recent research from our lab suggesting that one's emotional state literally primes the brain and body to expand or reduce the amount of information taken in from the world. Finally, we will review the amygdala's role as an important hub mediating embodied attention by linking attentional and bodily systems in perceptual filtering, and discuss this role in terms of the evolutionary and developmental advantages that such a system might bestow.

## MOTIVATED ATTENTION

### *Enhanced Visual Processing of Emotionally Arousing Images*

A body of research on "motivated attention" has investigated the hypothesis that emotionally salient stimuli enjoy privileged perceptual processing – that emotionally arousing images are processed more rapidly and more vividly than neutral images, and require less top-down attention to reach awareness. For example, this body of research has consistently demonstrated that emotionally salient images elicit higher levels of activation in the visual cortices than neutral stimuli. Functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) studies have found that, in several regions of visual cortex, positive and negative emotionally arousing scenes elicit greater activation than neutral ones (Pessoa et al., 2002; Bradley et al., 2003; Lane, Chua, & Dolan, 1999; Lang et al., 1998). Event-related potential (ERP) studies suggest that the effect of motivational salience – the importance or relevance of an image to one's well-being – on visual processing is also rapid, occurring within 170 ms of stimulus onset for faces (Blau, Maurer, Tottenham, & McCandliss, 2007; Pizzagalli, Regard, & Lehmann, 1999), and between 200 and 300 ms for complex scenes (Schupp, Junghofer, Weike, & Hamm, 2003; Schupp et al., 2008; Smith, Cacioppo, Larsen, & Chartrand, 2003). As brain regions activated in these studies have also been shown to be responsive to manipulations of top-down attention (Lane et al., 1999; Pessoa et al., 2002), our own questions have centered on investigating interactions between bottom-up emotional orienting responses as well as top-down attentional demands.

### *Attentional Blink*

In a series of behavioral studies, we investigated the hypothesis that emotionally significant events enjoy a privileged attentional status during perceptual processing, requiring less top-down attention than neutral stimuli to reach awareness. To examine this question, we used an attentional blink (AB) paradigm in which two target words are embedded in a stream of rapidly presented distractor items (Figure 7.1) (Anderson, 2005). The blink effect occurs when the second target (T2) is presented within 500 ms of the first target (T1). During this brief time window, awareness of T2 is impaired, a phenomenon thought to occur because perceptual encoding of a stimulus requires short-term consolidation processes. Short-term consolidation processes involve the “gluing” of perceptual features (e.g., shape, contour, edges) into a Gestalt so that an object or scene enters visual short-term memory and is available to awareness. Such consolidation is thought to require attentional resources that are limited in capacity. During short-term consolidation, attention can be seen as the glue that binds these featural aspects of a stimulus so that an object is processed as a whole. Featural binding is required in turn for an item to enter working memory. The AB is generally interpreted in terms of temporally limited processing resources, where the processing of T1 takes up all of the attentional resources required for the consolidation of the stimulus in working memory. These attentional resources are then unavailable for processing T2 until consolidation processes are complete. In other words, the blink is thought to reflect attentional limitations, during perceptual encoding, that gate the experience of seeing.

In order to probe the effects of stimulus salience on awareness, we conducted a series of AB experiments. The first study compared the blink effect for negatively valenced high-arousal words (e.g., “rape”), negative low-arousal words (e.g., “hurt”), and neutral words (e.g., “rule”). Results showed that there was the smallest blink effect, or the greatest AB sparing, for negative high-arousal words over negative low-arousal words, which in turn were spared over neutral words. In other words, the word was more likely to be perceived, and thus the typically found attentional blink was “spared,” if the word was high in arousal. The second study showed that the same pattern held for positive words, and suggested that the blink is modulated by emotional arousal elicited by the stimulus rather than by valence.

The next series of experiments was designed to rule out the possibility that the AB sparing was driven by other distinctive features of the arousing words. First,

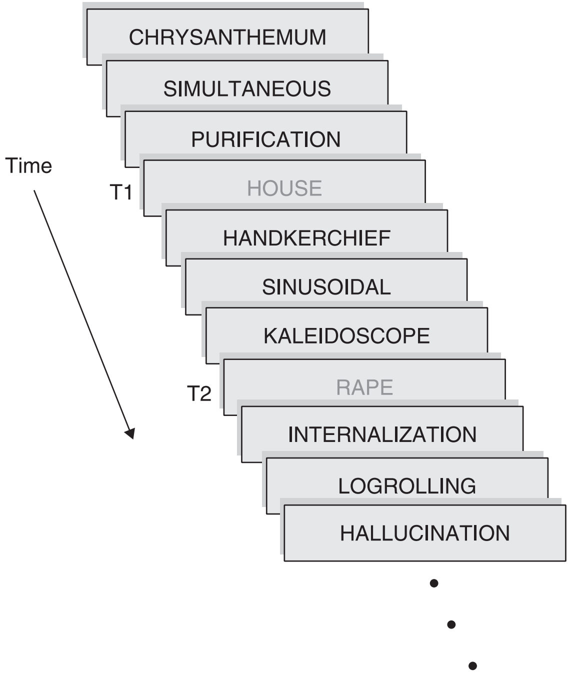

FIGURE 7.1 A dual target rapid serial visual presentation (RSVP) task used to measure the attentional blink. Fifteen words were briefly presented. Participants were instructed to ignore words appearing in black and report the identity of the target words appearing in green (colours not shown here). The time lag between the first (T1) and second (T2) target was varied. When T2 is presented within 600 ms of T1, the attentional blink typically occurs. (From Anderson and Phelps (2001), reprinted by permission from Nature Publishing Group.)

we controlled for the physical features of, and response biases toward, emotional and neutral stimuli by creating a set of neutral words from arousing words by transposing one letter (e.g., “rape” became “rope,” “cancer” became “dancer”). This demonstrated that observers did not reveal a response bias toward reporting negatively arousing words under conditions of uncertainty (e.g., rape vs. rope) or that low-level features common to arousing words were responsible for AB sparing. In the next experiment, to ensure that the special status of arousing words did not reflect that they were more unusual or distinct than neutral words, we used such unusual neutral words as “Ballyhoo” and “Crump.” To ensure that it was not the relative rarity or unexpectedness of arousing words driving the AB sparing, the task was next reversed so that neutral targets were surrounded by arousing distractors. Here neutral targets were reported less accurately when surrounded by arousing distractors than by neutral distractors. Thus, there was *less* AB sparing, or more of an attentional blink, when neutral targets were rare than when they were common, confirming that AB sparing was not the result of encountering unexpected words.

We went on to look more directly at whether the arousal value of a word influences resource-limited encoding processes, and therefore influences awareness. We designed a version of the task in which T1 is ignored since, if T1 is ignored during encoding, resources should not be challenged by T1 processing. Thus, if AB sparing of emotional words is the result of an advantage for emotional stimuli in encoding processes that gate awareness, there should be no such advantage if T1 is ignored. Results showed no AB sparing of emotional words in this version of the task, suggesting that the advantage for arousing stimuli interacts with capacity-limited encoding. When resources are not limited, the advantage for arousing words disappears. It is only when T1 is attended to and attentional resources are tied up in encoding that one can observe the advantage for arousing words in entering awareness. This evidence indicates that perceptual report of emotionally arousing stimuli does not reflect post-encoding/post-attentional filters, such as differential susceptibility to forgetting prior to report. Rather, emotional arousal interacts with attention to enhance perceptual encoding and awareness.

The next series of studies investigated whether the AB sparing results from a bottom-up or top-down interaction with attentional resources. Here we reasoned that, if the processing advantage is primarily independent of top-down attention, the capacity to report arousing T2 stimuli should not depend on how quickly or accurately participants respond to the T1 stimulus. In the next version of the task, to measure how long and well T1 was processed, we asked participants to respond to whether T1 was an X or an O. Results showed that AB sparing for arousing T2 words was not accompanied by decreased T1 accuracy, and longer T1 latency had less effect on arousing than neutral T2 stimuli. This finding suggested that AB sparing is not dependent on top-down attention as measured by T1 accuracy and processing time. That is, T2 arousing stimuli did not steal attentional resources devoted to T1 processing; rather, consolidation into awareness was relatively independent of these resources.

Over all of the experiments, the arousal content of T2 words effected a significant change in the magnitude and time course of the attentional blink. The change was not related to the physical features or the novelty of the arousing words, suggesting that arousing T2 words enjoy a privileged attentional status that allows them to more easily reach awareness. In fact, we demonstrated that AB sparing was a property not of the stimuli themselves, but of the observer's subjective emotional response to them, as AB sparing for arousing stimuli was predicted by the degree of experienced emotional arousal. Moreover, our results indicate that this privileging is characterized by a relative enhancement of pre-attentive, subcortically driven stimulus processing. In other words, when attentional resources were limited, emotional events required less attention to initially enter awareness. This is consistent with the idea that emotionally arousing events enjoy a relative, not complete, attentional independence during encoding. We concluded that perceptual representations of arousing events may burn brighter and longer relative to competing neutral distractor events. The result of this enhanced initial encoding of emotionally salient events may nevertheless result in greater and sustained engagement of attentional resources, when available. This greedy capture of precious resources may maintain the focus of consciousness on emotionally provocative events. However, for the brain to prioritize attention to emotionally salient stimulus events, increased attention must be logically preceded by accelerated perceptual and semantic processing during initial encoding.

We were interested in neural mechanisms that might allow such a privileging of emotionally arousing stimuli to be partially independent of limitations in top-down processing. We proposed that the amygdala, which sends projections to numerous regions of visual cortex (Amaral et al., 2003), may work by "diminishing the burden" of top-down processing resources when stimuli are emotionally important. Evidence for this proposal came from a study using the attentional blink paradigm in patients with amygdala lesions (Anderson & Phelps, 2001). This lesion study was designed to investigate the hypothesis that, in addition to its more established role in enhancing long-term memory consolidation, the amygdala plays a critical role during initial encoding, modulating perceptual consolidation to enhance both detection and memory of motivationally salient stimuli.

In this study, we began by measuring AB performance in SP, a patient with bilateral amygdala lesions, and a group of healthy controls. SP showed a normal attentional blink effect for neutral targets, but unlike the controls she did not show the pattern of AB sparing for negatively arousing words. To rule out a more global deficit in perceptual encoding, we manipulated the visual similarity of targets and distractors. SP showed AB sparing for more perceptually discriminable words, but no AB sparing for emotional words. This finding suggested that the affective modulation of perceptual awareness is dissociable from modulation by low-level perceptual features, with the former mediated only by the amygdala. Thus, we concluded that the amygdala modulates perceptual awareness with respect to emotional but not perceptual salience.

We then explored whether, given the importance of the left hemisphere temporal cortex in visual word representation, emotional sparing of the attentional blink was specifically driven by the left amygdala. We examined a group of five patients with right amygdala damage and five patients with left amygdala damage. Results showed that patients with right amygdala lesions performed like controls, and showed affective AB sparing, whereas patients with left amygdala lesions, like SP, showed no sparing for emotionally arousing words. This suggests that the amygdala may be modulating lexical representations specifically in the left temporal cortices to enhance their access to awareness. As the amygdala is not implicated in semantic storage of emotional words, it must act in concert with the left temporal cortex to encode the physical features of, and extract meaning and emotional value from, the word forms.

We next investigated whether the lack of AB sparing for negative words was linked to lack of overall comprehension of the emotional value of words by asking SP and the left amygdala patients to rate the valence and arousal levels of target words. All participants rated the negative stimuli as more negative and more arousing than neutral words, indicating that impaired influence of emotional content on perceptual awareness was not related to overall differences in comprehension of the emotional value of words. Further studies with SP and other lesion patients indicated that amygdala activation is causally related to the perception but not the generation of emotional expressions (Anderson & Phelps, 2000), and that amygdala damage does not result in altered magnitude, or frequency of emotional states (Anderson & Phelps, 2002). Thus, amygdala lesions do not necessarily decrease the experienced aspect of emotion, nor understanding of the overall significance of arousing stimuli. Here we concluded that the amygdala is not necessary for the experience of an emotional state, which in humans may be more tied to internal emotional representations than to direct perceptual experience. Rather, our studies suggest that amygdala lesions impair the enhanced perceptual processing of emotionally arousing stimuli, as well as the prominence of emotionally salient events in memory.

Together, these findings suggest that amygdala lesions result in an inability to modulate the *efficiency* of perceptual processing mediated by other brain regions. Signals from the amygdala, which is directly connected to many regions of visual cortex (Amaral et al., 2003), may enhance sensitivity in perceptual cortices as the amygdala trains the visual system to respond at lower activation thresholds. Less attention is then required for salient stimuli to activate the visual cortices. Thus, a key function of the amygdala may be to segregate neural representations of the significant from the mundane by shaping perceptual experience directly. We suggest that amygdala tuning of perceptual efficiency underlies the processing advantage of salient stimuli even under conditions of limited attention. The amygdala may work by "diminishing the burden" of central processing resources when stimuli are emotionally important. It is in this sense that emotionally arousing stimuli are processed relatively automatically and preattentively – that is, even when one is not explicitly aware that one has seen them. These stimuli may recruit a specialized orienting system centered around the amygdala, rather than depending exclusively on higher order attentional systems. In this way, the amygdala can aid in perceptual processing of emotionally salient events even when precious higher order resources are tied up with concurrent tasks. We suggest that the amygdala serves as a hub of a more primitive, evolutionarily conserved system for bottom-up processing that is tightly linked to the body's response systems. Our evidence suggests that this older system functions partially independently of a more evolutionarily evolved attentional system dependent on the cerebral cortex.

But what specific mechanisms underlie the amygdala's role in enhancing perceptual processing? The dual-route model of emotional processing (Ledoux, 1996) proposes that there are two routes by which the amygdala receives information about the visual world. According to this model, a subcortical, thalamo-amygdala "low road" sends visual information directly to the amygdala, bypassing the neocortex. Information sent through this route is crude, but may contain enough information about salience to influence amygdala activation – which in turn can enhance processing in the perceptual cortices. It has also been proposed that, in humans, information about stimulus salience may be rapidly carried by an alternate cortical route. According to this model, low spatial frequency visual information travels via a magnocellular pathway in the dorsal stream through the orbito frontal cortex, and then to the high level visual cortices for more refined processing. In contrast, the slower cortical "high road" sends more detailed information to the amygdala from the perceptual cortices. A study by Anderson, Christoff, Panitz, De Rosa, and Gabrieli (2003a) used fMRI to test an alternate route model in humans while investigating the effect of attentional load on emotional processing.

In this study (Anderson et al., 2003a), images of fearful, neutral, and disgusted faces were superimposed on images of buildings. Participants were asked to judge either the gender of the faces (attended condition) or whether they were viewing the inside or the outside of a building (unattended condition) (Figure 7.2). We then looked at the effect of emotional expression and top-down attention on activation patterns in the visual cortex and the amygdala. Results showed a direct effect of attention on visual cortex activation. The fusiform face area (FFA), a region of extrastriate visual cortex in the temporal lobe that responds preferentially to faces over other types of objects, showed greater activation in the attended condition, when participants attended to faces, whereas the parahippocampal place area (PPA), a region of the temporal lobe that responds preferentially to places/visual scenes, showed relatively greater activation in the unattended condition, when participants attended to places. Thus, activation in visual cortex was directly related to the degree of attention paid to the stimulus, regardless of emotional content of the images.

In contrast, for the amygdala, there was an interaction between the degree of attention paid to a stimulus and the response to emotional expression. When participants were attending to faces, the amygdala showed greater activation for

FIGURE 7.2 Example stimulus from face-place object selection task. Before each trial participants saw a prompt indicating whether they should attend to the gender of the face (attended condition) or to whether they were viewing the interior or exterior of a building (unattended condition). (From Anderson et al. (2003b), reprinted by permission from Society of Neuroscience.)

fear faces than disgusted or neutral faces. But when participants were not attending to the faces, the amygdala responded equally to fear and disgust. Further, the amygdala responded equally to fear faces during attended and unattended conditions, suggesting that partial attentional distraction did not diminish the response to fearful faces. We concluded that, in conditions of impoverished attention, the amygdala responds more globally or crudely to what is salient – to the arousal/intensity levels of the stimulus. This suggests that increased top-down attention enhances the specificity of the amygdala response.

With expressions of disgust there was an inverse relationship between cortical and amygdala processing that varied with attention: Cortical processing of disgust faces (in the insula) in attended conditions increased as amygdala processing decreased. This pattern was reversed in unattended conditions, when amygdala processing increased and cortical processing decreased. Thus, when attention is impoverished, there is more crude amygdala processing relative to the more fine-grained categorization and processing of detail that is mediated by the cortex. These data suggest that, whereas the amygdala tags motivational relevance, or salience, regions of ventral visual cortex mediate refined categorical processing, and attention enhances the latter relative to the former.

Overall these results suggest that, although the magnitude of amygdala response may be mediated by a “rapid road” that is partially independent of more refined cortical processing, the specificity of its response depends on extrastriate input along a cortical “slow road.” This interaction between automaticity and specificity of the amygdala response was the first human evidence of functional consequences of an alternative route model. We concluded that the rapid road allows for rapid, relatively automatic processing of crude visual features related to stimulus salience; the slow road allows for more detailed, but slower and more attentionally gated processing. The cost of the rapid road is specificity. Amygdala response is thus influenced by inputs that are less attention-dependent and may bypass regions of the ventral visual cortex, as well as inputs that are more attention-dependent and are received through the ventral stream of the visual cortex.

Another fMRI study further probed the role of the amygdala in tagging salience and tuning perception by asking whether the amygdala is more sensitive to the emotional valence or the intensity of a stimulus (Anderson et al., 2003b). At the time of this study, effects of arousal and valence were frequently conflated because many negative or fear-relevant stimuli (such as a decapitated body) elicit higher levels of arousal than positive stimuli (such as a bunny). Furthermore, most aversive stimuli get more aversive as you increase intensity. For example, the sound of fingernails on a chalkboard becomes more grating as it gets louder. In this study, by using olfactory stimuli, we were able to dissociate intensity and valence. Using odorants additionally afforded a more pure measure of valence, stripping away many of the high-level processes involved in appraising the emotional significance of complex scenes, which have often been employed in characterizing amygdala response. Here we collected fMRI data while presenting participants with high and low concentrations of citral, which has a pleasant, lemony odor, and valeric, which is generally perceived to be unpleasant. Results showed that the amygdala responded to the intensity of the odor for pleasant and unpleasant odors alike. In contrast the orbitofrontal cortex (OFC) was sensitive to valence rather than intensity, with the lateral OFC responding more to unpleasant, and the medial OFC to pleasant, odours. Moreover, activation patterns in the amygdala correlated with participants' ratings of the intensity but not the valence of the odours, and responded to all odours more than to clean air. Thus, there were differences in amygdala activation when valence was held constant and intensity manipulated but not when intensity was held constant and valence manipulated. We concluded that the amygdala is related directly to the experience of intensity, notwithstanding whether the stimulus is experienced as pleasant or unpleasant. Thus, the amygdala is primarily responsive to crude stimulus properties rather than more differentiated valence-dependent properties that may depend on further processing mediated by the orbitofrontal cortices. This dovetails nicely with a potential mechanism by which the amygdala may bias perceptual processing – including visual processing – to a stimulus prior to its complete cortical processing. This primitive valence-independent response suggests the amygdala might enhance cortical arousal and encoding of sensory events prior to their complete processing, resulting in enhanced access to awareness.

In summary, the attentional blink studies established that emotional stimuli have privileged access to awareness when attentional resources are stressed. Further, this advantage is dependent on the amygdala. The fMRI studies provided evidence for an alternate route model of visual processing, including a fast route for rapid transmission of salience-related visual information to the amygdala, and showed that the amygdala is more sensitive to arousal/intensity than valence.

## *Individual Differences and Developmental Changes in Motivated Attention*

In addition to normative findings that emotionally arousing images elicit greater visual cortex activation, enjoy privileged access to awareness, and are associated with the subjective experience of sensory vividness, there is also evidence of individual and developmental differences in biases towards positive vs. negative stimuli. A large body of behavioral and ERP evidence indicates that temperamental anxiety is associated with selective processing of threatening stimuli, and that this processing bias is rapid and relatively automatic (Armony & Dolan, 2002; Bishop, Jenkins, & Lawrence, 2007; Holmes, Nielsen, & Green, 2008). Such biases are associated with lower thresholds for amygdala activation to threat (Bishop et al., 2007; McClure et al., 2007) Moreover, there is evidence that attentional biases are linked to trauma (Beck, Freeman, Shipherd, Hamblen, & Lackner, 2001; Buckley, Blanchard, & Neill, 2000; Vythilingam et al., 2007), and can be learned through conditioning (Armony & Dolan, 2002; Lim, Padmala, & Pessoa, 2008; Padmala & Pessoa, 2008). In an extreme example of processing bias, people suffering from post-traumatic stress disorder (PTSD) show heightened amygdala and perceptual sensitivity to stimuli associated with the trauma (Gilboa et al., 2004; Hendler et al., 2003). Although most research to date has focused on biases to threat, there is increasing evidence of individual and developmental differences in biases for positive stimuli (Brosch, Sander, Pourtois, & Scherer, 2008; Mather et al., 2004). Thus, consistent with the amygdala's role in learning emotional associations, experience and temperament may both play a role in individual differences in what stimuli are tagged as salient.

Recent research has also found evidence of developmental changes in the valence or category of images that preferentially activate the amgydala and its influence on visual processing. In a developmental study (Todd, Evans, Morris, Lewis, & Taylor, in press), young children (aged 4–8 years) and young adults (18–33 years) viewed images of personally familiar (their mothers) and unfamiliar faces with angry and happy expressions. Adults showed a tendency toward greater activation for angry faces, consistent with previous studies showing a "negativity bias" in young adults. In contrast, children showed preferential amygdala activation for happy vs. angry faces. This study – among the first to measure amygdala activation in children as young as 4–5 years – adds to behavioral evidence suggesting that, like older adults, young children have a bias towards positively valenced stimuli (Mather et al., 2004; Qu & Zelazo, 2007; van Duijvenvoorde, Zanolie, Rombouts, Raijmakers, & Crone, 2008). These results suggest that, although by the time children enter school amygdala cortical circuits supporting privileged visual encoding of salient stimuli appear to be in place, the salience of positive vs. negative stimuli may shift with developmental context.

Moreover, individual differences may become increasingly pronounced over development as amygdala-mediated associative learning tunes the visual system towards specific categories of stimuli (Lewis & Todd, 2007). For example, research by Fox and colleagues suggests that children with at least one short serotonin transporter allele (5HTTLPR), a genetic profile associated with both temperamental fearfulness and increased amygdala reactivity, are more likely to experience a family environment that highlights threat. This repeated experience with caregivers in turn reinforces an attention bias to threatening stimuli (Fox, Hane, & Pine, 2007; Fox et al., 2005). Nonetheless, such developmental reinforcement of threat bias is not inevitable. Recent research has also shown that children high in negative affect who are also high in the trait capacity for effortful control, which includes the ability to volitionally focus and shift attention, do not show the attention bias to threat that is characteristic of children with high negative affect and low effortful control (Lonigan & Vasey, 2009). Although there is far less published data on positivity bias in development, there is growing interest in this topic. We would hypothesize that children high in extraversion show an attentional bias towards positive stimuli – including smiling faces – which is reinforced by repeated experience of social reward. Future research can investigate the development of co-activation patterns between the amygdala and visual cortices that are correlated with the emergence of individual differences in both *what* and *how* salient stimuli are preferentially processed.

## MODULATION OF VISION BY EMOTIONAL EXPRESSION AND STATE

### *Modulation of Sensory Processing Through Emotional Expression*

Having demonstrated in a number of studies that the salience of a stimulus modulates visual processing, we were interested in shifting the focus from the stimulus to the perceiver, and investigating how physical/emotional state may influence perceptual gating. Here we looked to Darwin, who suggested that facial expressions of emotion serve to modify preparedness for perception and action in the face of an important event (Darwin, 1872/1988). He proposed that the role of facial expressions in social signaling may be built on a more basic function in restricting or increasing access to sensory information.

In a recent study (Susskind et al., 2008) we asked: If viewing fearful expressions has been shown to increase visual processing, does producing fearful expressions do the same thing? From a Darwinian perspective, is the role of facial expressions in social communication built on muscular patterns that serve the more basic pattern of expanding or reducing sensory intake? Here we set out to examine two Darwinian principles of expressive behavior: the principle of *function* and the principle of *form* (Darwin, 1872/1988). According to the principle of function, facial expressions arise from muscle actions that serve an adaptive function for the producer of the expression. According to the principle of form, expressions that serve opposite functions, such as increasing or reducing sensory intake, are opposite to each other in muscle action pattern.

To test the principle of form, we used a computer graphics model of facial expression to test statistically whether facial expressions of fear and disgust were opposite in form. By manipulating prototypical models of facial expressions, we created a prototype expression for fear and then manipulated shape and surface reflectance features to create an "anti-fear" face. Not only were anti-fear faces most similar to disgust faces based on featural characteristics but, in an expression recognition task, participants rated anti-fear faces as disgust more than as any other emotion. The same process was repeated with disgust. Again, "anti-disgust" faces were most structurally similar to, and most likely to be rated as, fear faces. We then modeled the muscular action patterns underlying the oppositions in fear and disgust expressions (Figure 7.3). In comparison with disgust, the fear expression was characterized by an expanding, elongating longitudinal action around the mouth, nose and eyes, suggesting muscular actions involved in sensory vigilance, and disgust invoked the opposite, a longitudinal compression suggesting muscular actions involved in sensory rejection.

Next, we set out to test whether fear and disgust are opposite in *function*, allowing expanded vs. reduced perception. Using the computer model to further test predictions regarding specific measures of sensory regulation, we found that fear was characterized by eye-lid opening and brow raising, and disgust in eye-lid lowering and eye closing, altering visual input. We next tested the effects of facial expression on the visual field in human participants. In our initial perimetry tests, participants stood in front of a grid and judged the size of their visual field while

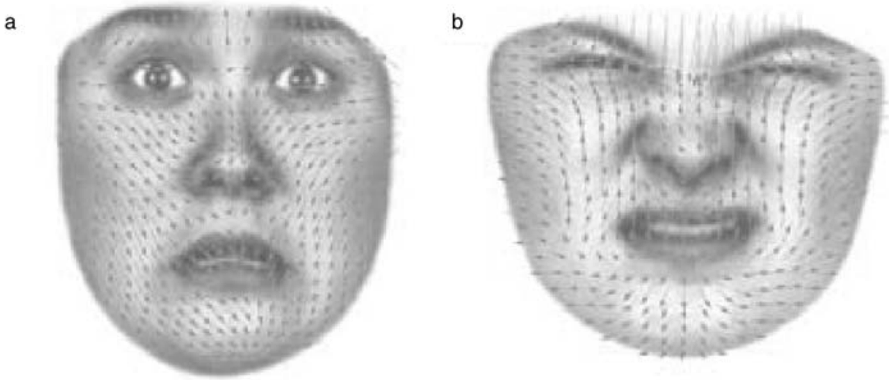

FIGURE 7.3 Opposition in facial actions between fear and disgust expressions. Arrows show patterns of facial muscle actions from antifear to fear (a) and antidisgust to disgust (b), which indicate expansion vs. compression longitudinally from the bridge of the nose. This longitudinal movement results in raised vs. lowered brows, opened vs. closed eyes, and the elongation vs. compression of the nose that accompanies raised and lowered lips. (From Susskind et al. (2008), reprinted by permission from Nature Publishing Group.)

posing fear and disgust expressions relative to neutral expressions. Participants drew subjective changes in their visual field on a small hand-held version of the grid. Producing fear expressions was found to increase the perceived visual field, specifically the upper half, consistent with raised brows and lids. Producing disgust expressions was found to decrease the size of the perceived visual field, consistent with brow lowering and the cheek raising that results from a wrinkled nose. Moreover, eye actions filmed during the production of facial expressions predicted subjective impressions of visual field size. The facial expression that was produced also predicted participants' objectively measured ability to detect simple sensory onsets in the upper level of the visual field, again with fear enhancing and disgust reducing stimulus detection. Overall these studies demonstrated that producing facial expressions of fear and disgust regulates the size of the visual field, and thus the amount of visual information coming in from the world.

We then examined whether the expansion of the eyes in fear faces might serve to prepare action patterns for increased scanning of the visual environment. In the next study, eye movements were measured as participants performed saccades between two horizontal targets while posing fear, disgust, and neutral expressions. Eye movements were fastest for fear and slowest for disgust, demonstrating that fear faces also increase the speed of foveation of objects in the visual field.

This series of studies provides evidence that, prior to their function in social communication, fear and disgust expressions may serve a basic physical function that allows us to take in more of the visual world when faced with threat, and less when faced with contamination. In the case of fear, visual capacity is increased in the face of a novel or unexpected stimulus, allowing for subsequent activation of a repertoire of defensive and protective actions. We propose that in this case the amygdala again may serve as a key link between one's physical/emotional state and attentional modulation of visual processing. Through its downstream connections, the amygdala also relays signals to the body to modulate perception by using muscular action to take in more or less of the world. The effect of emotion on stimulus processing is not restricted to the central nervous system, but begins through configuring one's face to maximize or minimize exposure of the sensory organs.

## *Expansion of the Visual Field with Positive Affect*

Our finding that *expansion* of sensory surfaces was associated with fear faces was consistent with findings showing increased amplitude of activation in the visual cortex for fear vs. neutral faces (Pessoa et al., 2002; Sabatinelli, Bradley, Fitzsimmons, & Lang, 2005; Surguladze et al., 2003). Yet these findings appear to be at odds with a number of behavioral studies suggesting that negative affect results in a *contraction* of the attentional beam to focus on the stimulus/ circumstances at hand (Christianson, 1992; Gasper & Clore, 2002; Kensinger, Garoff-Eaton, & Schacter, 2007). In contrast, positive emotion is associated with a more flexible, exploratory attentional style, with a focus on gist rather than detail (Fredrickson, 2002; Fredrickson & Joiner, 2002; Gasper & Clore, 2002; Isen, Daubman, & Nowicki, 1987; Rowe, Hirsh, & Anderson, 2007). For example, in a study examining the effects of mood on visuospatial and semantic processing (Rowe et al., 2007), we induced positive and sad emotional states in participants before they performed a flanker task, in which participants indicate the direction of a central target that is surrounded by either compatible or incompatible distractors. We found that, in the positive-mood condition, participants showed greater response slowing for incompatible trials than in neutral or sad conditions, especially when distractors were spaced further apart. This indicated that inhibition of distracting information is impaired, and the spotlight of selective attention is literally broadened, by positive affect. Interestingly, this broadening of perceptual processing was correlated with a broadening in the flexibility of semantic processing in a positive state, as participants were also able to come up with more word associations requiring meta-level categorization than in other states. In this study we did not find an equivalent contraction of processing associated with the negative state. However, attentional contraction, or "weapon focus" is associated theoretically more with anxiety than sadness.

The literature suggests that anxiety should affect the central nervous system by narrowing and focusing activation in the sensory cortices. In our next investigation of the effects of mood on sensory processing, we used fMRI to examine whether mood *literally* contracts or expands the area (rather than the amplitude) of processing in the visual cortex (Schmitz, De Rosa, & Anderson, 2009). We did so by investigating the effect of mood on responses in extrastriate visual cortex to specific categories of objects. Specifically, we hypothesized that negative mood would decrease the processing of task-irrelevant visual distractions. Conversely, positive mood should decrease the ability to filter irrelevant information.

In this fMRI study, we induced positive and negative affect by showing series of positive, neutral, or negatively valenced (threatening) pictures before participants performed a visuospatial attention task. After a block of these mood induction images, participants viewed small, foveal pictures of faces that were surrounded by larger images of houses, and were asked to report the gender of the face. Thus, the task required participants to attend to a central image and ignore information from a peripheral one. Cortical activation was then measured in an extrastriate region known to respond selectively to places (the PPA). Results showed that, in general, the amygdala was more active for the negative mood induction. Negative affect was associated with less PPA activation than positive or neutral states, indicating that negative mood was associated with less cortical processing of peripheral visual information. To investigate differences in the *degree* of peripheral information processing associated with mood, we then measured repetition suppression, which is a reduction in brain activation that occurs when the same image is repeated one or more times. Here, positive mood evoked the greatest amount of repetition suppression, suggesting greater initial processing of peripheral information in a positive emotional state. Moreover, participant reports of greater positive affect predicted increased perceptual encoding of unattended peripheral stimuli, whereas reports of greater negative valence predicted less peripheral place processing. Finally, investigation of patterns of co-activation between the PPA and primary visual cortex suggested an increase in coupling between these regions with positive affect, and a decrease in coupling with negative affect. This finding suggests that a positive mood state facilitates the flow of sensory information from early visual processing regions to extrastriate regions specialized for higher-level processing. In contrast, negative states are associated with a more circumscribed processing of sensory inputs.

This study demonstrated that emotional state can influence visual cortical processing regardless of the salience of the stimuli. Moreover, positive and negative states created opposite effects, with positive affect increasing task-irrelevant peripheral processing and negative affect reducing it. We concluded that emotional states fundamentally bias the attentional lens through which perceptual experience is filtered. The analysis of functional connectivity further suggests that this biasing effect has an impact on initial stages of visual processing – that emotional state tunes the perceptual cortices to differentially process incoming perceptual information, and that this may be more non-selective with positive affect.

At first glance, the finding that negative affect *narrows* sensory processing in the central nervous system appears to be at odds with the finding that production of fearful expressions *expands* the extent of peripheral processing. One explanation of these contradictory findings is that the two studies not only tap differences between central and peripheral responses, they tap different aspects of emotional experience, which unfold in different contexts and at different time scales. The Susskind et al. (2008) study indicates that producing a fear face expands sensory gateways in order to increase eye movement speed. Such increased eye movement speed may allow us to scan the environment more rapidly in order to identify and focus on important features of the environment – particularly in an ambiguous situation. Facial expressions are produced very rapidly (Darwin, 1872/1988;

Ekman, 2001) in response to sudden events, and may serve to increase the amount of visual information taken in before an environmental threat has been explicitly identified. Thus, the production of fear faces (like neural responses to viewing rapidly presented fear faces) may be tapping rapid – and evolutionarily older – responses to a sudden event, linked to a burst of amygdala activation, that unfold over the course of milliseconds and seconds. Such a sudden response may initially occur relatively independently of cortical processing. In contrast, the Schmitz et al. study evoked moderate levels of negative affect that were sustained over time, and within the context of a clearly delineated behavioral task that required ongoing top-down attentional focus and extensive cortical processing. Thus, in a negative emotional state, once the appropriate focus of attention is clear and ongoing, the amygdala may influence the cortex to reduce peripheral processing. Such suppression of distracting stimuli facilitates a "weapon focus" on stimuli that are relevant to the present context.

## THE ROLE OF THE AMYGDALA IN COORDINATING SUBCORTICAL AND CORTICAL SYSTEMS

We conclude by returning to the role of the amydgala in allocating resources to events of biological importance. Our motivated attention research contributed to a view of amygdala function that emphasizes its role in tagging salient stimuli for further perceptual processing, and facilitating an advantage for emotionally salient stimuli in reaching awareness. Alongside this research, our recent studies looking at the influence of emotional state and facial expression on perception point to a broader model of emotion and amygdala function stressing the amygdala's role in allocating both bodily and attentional resources towards important events.

Here, the amygdala is seen as a central hub facilitating prioritization and allocation of central and peripheral resources in service of one's goals. Geographically, the amygdala is optimally located to integrate information from the body and the world, and in turn influence both cortical and subcortical/peripheral responses. The amygdala has been shown to be anatomically linked to all but eight cortical structures (Young et al., 1994) and is literally central to the connectional topography of the central nervous system. In addition to sending direct projections to all levels of the visual cortex in the ventral visual stream (Amaral et al., 2003), it is linked to frontal and parietal regions that mediate top-down attention (Young et al., 1994).

Animal research suggests the amygdala is functionally associated with the thalamic pulvinar nucleus and the superior colliculus, subcortical structures important for attention and eye movements, and amygdala activation increases thalamic sensitivity to information from the retina (Cain et al., 2002), although such functional connections have yet to be established in primates. Moreover, stimulation of the amygdala increases overall cortical arousal and plays a role in attentional vigilance (Davis & Whalen, 2001; Hurlemann et al., 2007). In addition to upward connections with cortical systems, the amygdala has numerous downward links that modulate the body's response systems. Via connections to the hypothalamus and brainstem, the amygdala can evoke basic action repertoires (such as freezing and startle responses and facial actions linked to emotional expression) and trigger changes in heart rate, blood pressure, galvanic skin response, corticosteroid release, pupil dilation, and respiration (Davis & Whalen, 2001). Thus, connections from the amygdala to lower structures facilitate activation of the body's response systems, and connections from the amygdala up to the cortex allow the amygdala to harness perception, attention, memory, and planned action. Our research suggests that, as a central hub that influences the extent of both bodily and perceptual responses, the amygdala can guide allocation of both physical and attentional resources in a range of circumstances and at different time scales. Because the amygdala is implicated in emotional learning, its activation patterns are informed by past experiences, and it harnesses our central and peripheral responses accordingly.

On an ongoing basis, attention and awareness should be drawn to events of sufficient importance to alter metabolic resources – even if from moment to moment these changes are very small. We propose that redirection of the body's resources serves as the foundation of higher order attention and emotion processing in the brain, and the amygdala is the central locus linking evolutionarily older and newer processes. There is evidence that, like the peripheral system, the central nervous system is biased to devote metabolic resources to processing what is emotionally important. It has been suggested that "default" brain networks, which are densely linked to the amygdala and associated with emotional processing, have higher ongoing metabolic needs than other cortical regions (Raichle et al., 2001). This metabolic activity is thought to reflect ongoing activity that, among other things, allows facilitation or inhibition of perceptual responses to salient stimuli (Gusnard & Raichle, 2001).

One role of this ongoing processing bias is to maintain relatively automatic filtering of perception based on experience so that, as we go about our day-to-day business, we see the things that count. From a phylogenetic brain systems perspective, evolutionarily older subcortical systems may serve to harness more sophisticated and elaborated cortical systems, in parallel modulating the allocation of limited resources in the body and the brain. For example, the biasing system that allows us to rapidly spot a boss's angry face in a crowded room, tagging it for further processing, also entrains cortically mediated reasoning and memory processes as we review possible causes of her anger and strategies for damage control. These rapid appraisals further allow for changes in metabolic resources, as blood flow throughout the body is diverted in preparation for action, reflected in the pallor spreading across one's face as blood is drawn to large muscle groups related to flight. The amygdala may represent a central hub that adaptively harnesses these mental and bodily resources in responding to threats and challenges.

Moreover, our research suggests that amygdala-driven attention biases are in place early in development, but may shift according to developmental context and experience. From early on, children's wellbeing depends on discriminating facial emotion, particularly on familiar faces, but the relative importance of a given expression may change over time. A smiling mother's face, signaling safety, familiarity, and love, may be far more salient to a preschooler than to a teenager, whose attention is drawn by the contemptuous expression of a peer. Thus, there is adaptive developmental flexibility that allows us to adjust the emotional lens as the relative importance of certain aspects of the world change. In contrast, amygdala plasticity also allows for maladaptive salience, as in types of psychopathology such as PTSD that are characterized by a biasing of perception and memory to trauma-related aspects of the environment, which does not shift in response to change of context. In this case the adaptive emotional prioritizing of perception and attention can go awry and the attentional lens loses its flexibility, becoming fixed on external stimuli and internal cognitions more associated with life's threat than rewards.

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# 8

# Context and Social Effects on Face Recognition

MARIA PIA VIGGIANO and TESSA MARZI

## FROM PERCEPTION TO MEMORY: SOCIAL EFFECTS ON FACE RECOGNITION

Our aim in this chapter is to review the key findings to date concerning the physical–structural, emotional and social aspects of face perception and recognition. We explore the various processes that contribute to face processing and its link to social cognition and discuss the results of studies with diverse methodological approaches that indicate support for the contribution of these processes. Following a brief introduction, we outline the perceptual and structural processes as well as the neural circuits involved in face perception. This is followed by a review of the social and emotional aspects of face recognition that play a central role in human social cognition, such as facial expressions, facial beauty and trustworthiness. Finally, we discuss the neural basis and mechanisms underlying the extraction and processing of social cues.

Considerable progress has been made over the past 20 years in our understanding of the perceptual and cognitive processes that are involved in eliciting various kinds of meaning from the human face. Social cognitive neuroscientists have recently begun to investigate social skills such as recognizing, and remembering socioemotionally relevant stimuli. What makes us trust some people and not others? And what happens in our brain if we meet an attractive person?

When we filter social information, we preferentially process the most salient stimulus, and we use this information to construct a rich model of the social world that goes well beyond what the senses alone could provide for us (Adolphs, 2009). Our ability to recognize, manipulate and react to socially relevant information depends on our neural systems. Our neural systems process our perception of social signals and connect our perception to our motivation, emotion and adaptive behavior.

Faces are the most meaningful and important stimuli that we encounter and perceive every day, and convey a wealth of information. Structural aspects of the face reveal a lot to us about a person's identity, age, gender and ethnicity. Faces also provide socially relevant information, such as eye gaze, trustworthiness and attractiveness, as well as information about emotion through facial expressions. We watch faces closely during conversation, focus on cues about intention and feelings, honesty, and romantic and sexual interest. To interact within a social world, it is necessary to be able to recognize the identity of people, read their expressions to understand the meaning of their intentions, and making quick trait decisions about strangers. The impact that faces have on us is reflected in both how we perceive others and how we behave towards them, such as whether or not we choose to assist them, employ them, or invite them out on a date (Zebrowitz & Collins, 1997).

Facial appearance is important not only when our responses to a face could be argued to be relevant to our choices, but also when our choices should be made based on more objective grounds. For instance, facial appearance has been found to predict people's choices in relation to congressional elections (Todorov, Mandisodza, Goren, & Hall, 2005) and also with regard to criminal justice decisions (Eberhardt, Davies, Purdie-Vaughns, & Johnson, 2006). As such, some facial qualities provide adaptive information in social interactions and create impressions of faces that vary in attractiveness, emotional expression and trustworthiness. For example, people tend to attribute positive traits to attractive persons, judging them more intelligent, socially competent and healthy (Heilman & Stopeck, 1985; Langlois et al., 2000).

The sight of an attractive face gives us enormous pleasure. Beautiful faces activate reward centers in the brain (Aharon et al., 2001; O'Doherty et al. 2003), motivate sexual behavior (Berscheid & Reis, 1998; Feingold, 1914; Rhodes, 2006; Thornhill & Gangestad, 1999), and in accordance with the "what is beautiful is good" stereotype (Dion, Berscheid, & Walster, 1972; Eagly, Ashmore, Makhijani, & Longo, 1991; Langlois et al., 2000) people with appealing facial features are perceived in a better light and receive more positive treatment across a range of settings (Langlois et al. 2000) than those with unattractive faces. For example, people with a baby face are perceived to have childlike traits such as weakness, honesty and warmth and are inclined to elicit protective responses from others. Angry faces, on the other hand, are perceived as unattractive. A person with an angry face is perceived to have traits associated with low affiliation, a highly dominant attitude, and tends to elicit defensive responses from others (Zebrowitz, Kikuchi, & Fellous, 2007; Montepare & Dobish, 2003). Thus, facial qualities such as expression of emotion and attractiveness might convey information not only about affective state but also about behavioral tendencies. For example, happiness might convey a positive affective state as well as a friendly approach.

Our impressions of people and relative behavior towards them are also modulated by memory in terms of facial prototype. For example, the tendency to respond to strangers varies as a function of their resemblance to known people (DeBruine, Jones, Little, & Perrett, 2008). It has been found that we expect greater fairness from a teacher whose face closely resembles the prototypical face of teachers that we know to be fair, although we have no conscious awareness of the dimension on which the faces vary (Hill, Lewicki, Czyzewska, & Schuller, 1990).

Even when memory acts as a prerequisite for appropriate behavior in social settings, allowing people to recognize friends and – more generally – individuals that they like and those they would rather avoid, it is not immune to biases. Halberstadt and Niedenthal (2001) showed that faces that are thought about in terms of anger or happiness are later recalled as showing these emotions more frequently than they actually did. This could depend on the information that is encoded in the learning context, that is, information inherent to the stimulus as well as categorical information that is self-generated by the perceiver. In the case of poorer encoding of stimulus information, people are more likely to integrate this information with category information at recollection (Huttenlocher, Hedges, & Vevea, 2000). Thus, faces can be recalled as being more typical of a category that the perceiver initially associated with them than they actually are.

Facial expressions might also be influenced by the context in which they appear. It has recently been demonstrated that different kinds of contexts affect a person's recognition of facial expression. If a face is viewed in conjunction with a voice or body that expresses the same emotion, or if it is shown in a congruent emotional scenario, both the judgment accuracy and speed of the recognition of facial expression typically increase (Cox, Meyers, & Sinha, 2004; De Gelder et al., 2006; Righart & De Gelder, 2005; Tamietto, Corazzini, de Gelder, & Geminiani, 2006). Since facial expressions are our main way of communicating emotion, it was thought that facial expressions of basic emotions were universally recognizable. Recent research, however, has found clear, subtle differences in relation to how culturally diverse individuals decode emotions differently (Elfenbein & Ambady, 2003; Matsumoto & Ekman, 1988). Yuki, Maddux, and Masuda (2007) found that depending on a person's cultural background, facial cues in different areas of the face are differentially weighted when feelings are interpreted. When interpreting other people's emotions, people from cultures where it is the norm to suppress emotion (e.g., Japan) focused more on the eyes than on the mouth. People from cultures where overt expression of emotion is the norm (e.g., the USA) were inclined to use the position of the mouth as the main cue for interpretation of emotion since mouths are the most expressive facial feature.

The interaction between facial appearance markers and perceived emotion could lead to a gender-stereotypical effect, at least in western cultures. For example, the happiness expression shown by women is usually perceived as more intense while the anger expression is typically perceived as less intense compared to the same display of physical intensity of these emotions by men. These stereotypical expectations might be related to men and women's respective social roles (Brody & Hall, 2000). That is, women are usually expected to be more affiliative so that they can nurture others in their relationships. On the other hand, men's expression of anger may be more acceptable as a goal-directed behavior to overcome obstacles. However, Hess, Adams, and Kleck (2004) have shown that irrespective of gender, people who seem to be more affiliative are expected to display more happiness, and people who seem more dominant are perceived as more prone to the expression of anger. Thus, the perceived emotionality of males and females is in part mediated by the degree to which their faces are interpreted as reflecting a dominant or affiliative disposition. That is, anger expressions highlight some of the features that cause a face to seem dominant (e.g., a frown draws the eyebrows and eyes closer together, and the mouth area often seems to be more squarely set). A smile, instead, makes faces that we associate with affiliative and baby faces seem more round. That is, the facial cues associated with our impressions of affiliation and dominance are probably interacting with expressive cues, and it is likely that this interaction creates our impressions of underlying emotions that are consistent with gender stereotypical expectations (Hess et al., 2004).

So, how exactly do we extract the emotional and social meaning of the face from facial features? Understanding how we obtain this information from faces is one of the core aims of recent perceptual and cognitive models of face processing, and the results of eye-gaze studies have been invaluable in assisting us to refine our knowledge about this process. In social interactions, people's eyes convey a wealth of information about where their attention is focused and their emotional and mental states. Indeed, the ability to discriminate between direct and averted gaze across different species has an adaptive value. This skill may have evolved because direct gaze might signal that a predator is watching nearby, and it is therefore also an important survival skill (Emery, 2000). Equally, prolonged human eye contact might be perceived as a warning approach signal (especially when it is combined with the pointing gesture), as it could lead to increases in the physiological activation of fear (Nichols & Champness, 1971). Making eye contact is also a way of indicating attraction between people. For instance, recent research has found that when someone is seen to change the position of their eyes to make eye contact, they are perceived as more likable and attractive than if the person is seen to break eye contact (Mason, Tatkow, & Macrae, 2005). Jones, DeBruine, Little, Conway, and Feinberg (2006) found that this type of effect is modulated by the expression of emotion. That is, a face looking at you is considered to be more attractive when smiling than when its expression is neutral, whereas a face looking away from you is perceived as less attractive when smiling than when its expression is neutral.

The way in which an observer uses gaze cues is modulated by facial expression. Objects that are looked at by someone else are appraised in relation to the valence of the observed facial expression. Furthermore, someone else's direction of gaze can also have an impact on affective appraisals of others, and gender differences have been found to modify this effect. Jones, DeBruine, Little, Burriss, and Feinberg (2007) found that women consider male faces that are being looked at by a female face to be more appealing if the female face is smiling than if its expression is neutral. Instead, men judge male faces to be more attractive when the female face looking at the male faces has a neutral expression compared to when the female face looking at them is smiling. Judgments of gaze direction can be also influenced by the direction of the head. People are faster to make a judgment when the eye gaze and head are oriented in the same direction than when they are oriented in opposite directions (Langton, 2000). Therefore, our assessments about eye gaze are affected by the context of the face containing the eye area and our perception of gaze direction influences how we evaluate semantic aspects of the face (e.g., emotional expressions and likability). These influences are further modified by the nature of the social interactions in which they occur, such as whether the eye gaze or facial expression indicates approach or avoidance (Frischen, Bayliss, & Tipper, 2007).

All in all, faces are multidimensional stimuli that convey many important signals of social and emotional significance. Faces provide distinctive information not only about structural features but also related to emotional and social aspects, such as trustworthiness and attractiveness (Figure 8.1). We can communicate our thoughts or feelings by showing a particular facial expression and we can infer the thoughts or feeling of others from the expressions on their faces. Still, little is known about how these different dimensions are processed and how they are integrated into a single representation of a face. Research conducted in the fields of cognitive psychology, neuroscience, and neuropsychology has provided an elaborate model of the complex functional architecture underlying these different aspects of face processing, each presumably associated with specific neural substrates that are interconnected within a large-scale network.

## FROM PERCEPTION TO COGNITION

Interacting within a social world requires, first of all, the perception and recognition of people's identity. When face processing is severely impaired, due to brain damage or developmental problems, people experience great social difficulties (Duchaine & Nakayama, 2006). Recent progress in functional brain imaging has allowed a tremendous improvement in our knowledge of the neural underpinnings

FIGURE 8.1 Faces convey a wealth of information about structural aspects (identity, age, race, and gender) but also emotional and social signals (expressions, attractiveness, trustworthiness) that help us form our impressions of others. Face from Lundqvist, Flykt, and Öhman, 1998.

of the human face recognition system, and its operating properties. Neuroimaging studies have defined the cortical regions involved in the different aspects of face processing and electrophysiological techniques have shed light on their temporal dynamics. We first consider the question of whether or not faces can be considered to be special and then explore the processing of structural properties that contribute to face recognition mechanisms.

### Are Faces Special?

Is face perception carried out by specific neural mechanisms? This is a longstanding question under investigation in cognitive neuroscience. Several lines of evidence suggest that the neural and perceptual processes involved in face perception are distinct and segregated from those involved in the perception of other objects. A great deal of face perception research has focused on finding evidence for the specific mechanisms for face perception using neuropsychological, behavioral, neurophysiological, neuroimaging and electrophysiological approaches.

There is still disagreement, however, about whether the neurocognitive operations involved in face processing are face-specific (Carmel & Bentin, 2002; Farah, Wilson, Drain, & Tanaka, 1998; Kanwisher, 2000) or common to those recruited for identifying members of a visually homogeneous object category for which a person is expert. The latter processing is referred to as the expertise hypothesis (Diamond & Carey, 1986; Gauthier & Tarr, 2002; Tanaka & Curran, 2001).

According to this hypothesis, face recognition only seems special because adult humans have had extensive experience in discriminating individual faces but almost no practice in making similar within-class discriminations about objects. Face-specific cognitive and neural mechanisms might be recruited for skilled individuation of non-face homogeneous categories, such as birds, cars and dogs. After intensive perceptual training they may even be recruited for novel artificial face-like stimuli, which are referred to as Greebles. For example, dog-show judges develop perceptual expertise in discriminating exemplars of dogs of the same breed. Their significant experience with dogs could influence their visual processing in such a way that they may employ the same neural mechanisms for discriminating dogs that we employ for face discrimination.

Faces can be considered as special for several reasons. First of all, several studies have shown that newborns prefer looking at faces rather than at objects (Johnson, Dziurawiek, Ellis, & Morton, 1991; Simion, Valenza, Umilta, & Dalla Barba, 1998). Behavioral studies have used the so-called "face inversion effect" as a measure of specific mechanisms for face processing. Faces are harder to perceive, memorize and recognize when presented upside-down compared to when they are presented in an upright position (Yin, 1969). This phenomenon is clearly supported by increased reaction times and poorer accuracy for recognition of inverted versus upright faces and also, but to a lesser extent, with respect to inverted versus upright objects. This robust effect has been considered as evidence that upright faces are processed in a special way.

Another special aspect of faces is that they are processed as a whole rather than as the individual parts of the whole. Accuracy in discriminating individual face parts (such as the eyes) is higher when the entire face is presented than when the parts are presented in isolation, whereas the same "holistic" advantage is not found for parts of houses or inverted faces (Tanaka & Farah, 1993).

Perhaps the strongest evidence for specific face processing comes from neuropsychological studies of prosopagnosic patients. These patients are unable to recognize previously familiar faces, despite a largely preserved ability to recognize objects.

Furthermore, neuroimaging studies have also provided strong support for face-specific neural mechanisms, showing the existence of a region (called the fusiform face area) in the ventral visual pathway that responds more strongly to faces than to objects. The functional role of this region is now controversial. It could be a specialized area for face processing (Grill-Spector, Knouf, & Kanwisher, 2004; Kanwisher, 2000; Kanwisher & Yovel, 2006; Spiridon & Kanwisher, 2002), part of a more distributed object-recognition system (Haxby, 2001, Haxby et al., 2006; Ishai, Schmidt, & Boesiger, 1999; Ishai, Ungerleider, Martin, & Haxby, 2005), or an area subserving visual expertise processing that can be applied to any object category for which one has become expert. Evidence in favor of the latter possibility is that strong activations of the fusiform face area were found in car experts viewing different exemplars of cars (Bukach, Gauthier, & Tarr, 2006).

While neuroimaging studies are consistent in showing neuroanatomical specificity for face perception, they cannot establish exactly when such processing occurs given their poor temporal resolution. This issue can be investigated using event-related brain potential (ERP) techniques. Recording ERPs is a powerful and widely used method for tracking the time course of face processing from categorization to recognition. ERPs are fluctuations in the electrical activity of the brain which are time-locked to the presentation of sensory stimuli or to the occurrence of mental events. Since their temporal resolution is measured in milliseconds, ERPs can accurately identify when processing activities take place in the human brain. It has been repeatedly shown that faces elicit a specific negative potential (N), peaking at about 170 ms from stimulus onset, which is known as the N170 component (Bentin, Allison, Puce, Perez, & McCarthy, 1996; Eimer, 2000). N170 has become a temporal marker for specific face processing as it shows larger amplitudes and greater activation for faces compared to other object categories (Bentin et al., 1996) (Figure 8.2).

It has been suggested that face-specific mechanisms, which are reflected by N170, are triggered whenever a stimulus contains sufficient information to generate the concept of a face (Sagiv & Bentin, 2001). According to the expertise hypothesis, however, some studies have also shown an enhanced N170 when dog and bird experts were shown their respective animals of expertise (Tanaka & Curran, 2001). This might suggest that the degree of visual expertise might be critical in explaining at least part of the difference in the N170 between faces and objects (Tarr & Gauthier, 2000).

The issue of whether or not specialized neural mechanisms exist for face processing is still far from settled. Nevertheless, face information can be considered as special given the manner in which it is perceptually processed.

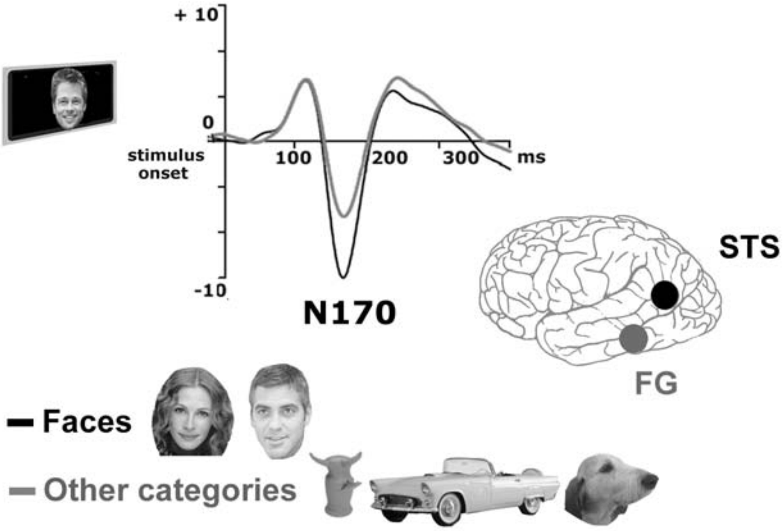

FIGURE 8.2 An early marker for face specificity: the N170 component. At about 170 ms from stimulus presentation faces elicit a larger amplitude with respect to other stimuli categories. FG = fusiform gyrus, in the temporal lobe; STS = superior temporal sulcus, near the top of each temporal lobe; these are the neural generators of the N170. Faces from Lundqvist et al., 1998.

## *Perceptual and Structural Processing*

When we look at someone's face, our visual system first needs to construct a perceptual representation that provides information about structural facial features and their configurations. Perceptual processing of facial features can then be linked to the generation of judgments and impressions about the person.

Current cognitive and neural models of face perception propose that there is an initial stage of encoding in which the structural features of faces are extracted. This information is then used to process face identity. Identity is processed via the lateral fusiform gyrus (including the fusiform face area) and subsequently through more anterior temporal regions that are involved in the recollection of biographical information.

An influential cognitive model of face perception has been developed by Bruce and Young (1986). They highlighted a distinction between processes involved in the recognition of invariant aspects of identity (e.g., the nose) and those involved in the recognition of expressions and changeable aspects (e.g., speech-related movements). According to this model, the processing of identity involves three different stages. The first of these is perceptual classification (face recognition units), which allows us to recognize a novel view of a familiar face. The second is semantic classification (person identity nodes), which provides access to identity-specific semantic information, and the final process is name retrieval.

More recently, Haxby, Hoffman, and Gobbini (2000) proposed a model based primarily on findings from functional brain imaging studies which have shown that face perception is mediated by several regions in a distributed neural system, a network of interconnected brain areas that work together. These regions are presumed to perform the analysis of different aspects of face perception. The region in the lateral fusiform gyrus (in the occipito-temporal pathway) appears to be preferentially involved in the representation of identity whereas the region in the superior temporal sulcus (in the upper part of the temporal lobe) appears to be more involved in the representation of changeable aspects of faces.

So, given this, what kind of perceptual information is elicited during the structural encoding of faces? Many studies have sought to understand the nature of the facial information that is extracted in this process. A distinction is made between featural (part-based), configural, and holistic processing (Yovel & Duchaine, 2006, 2008; Maurer, Grand, & Mondloch, 2002; Sagiv & Bentin, 2001; Rossion et al., 1999; Farah & Tanaka, 1991). Several lines of evidence suggest that faces are perceived and represented holistically rather than as single parts. That is, they are represented as a single unit in which face parts are processed interactively rather than independently. The expert skill of adults in recognizing faces has been attributed to a process called "configural processing" (Maurer et al., 2002). This consists of various components: (i) sensitivity to first-order relations: the arrangement of face features with two eyes above a nose, which is above a mouth; (ii) holistic processing: integrating the features into a whole; and (iii) sensitivity to second-order relations: perceiving the distances between features ("spacing"). Evidence that face-specific mechanisms process parts as well as spacing comes from research findings with developmental prosopagnosic patients (Yovel & Duchaine, 2006). These patients show severe difficulties in discriminating both parts and the spacing of faces despite normal performance on discrimination of houses.

To investigate which types of perceptual processing are related to particular face areas, a recent study (Pitcher, Walsh, Yovel, & Duchaine, 2008) used transcranial magnetic stimulation (TMS), a non-invasive technique that is characterized by a fine degree of temporal and acceptable spatial control, to disrupt the neural activity of a region in the inferior occipital gyrus, called the occipital face area. They found an impairment for the face part and not for the face-spacing discrimination, which shows that this area is crucial for analyzing individual face parts. This finding could have intriguing implications in the understanding of prosopagnosia. Fusiform face area may help in categorizing a face as a face based on the integration of features at the basic level, whereas the role of the occipital face area, which is often damaged in prosopagnosics, might be in finer analysis of face features (Pitcher et al., 2008; Rossion, 2007).

As far as the time course of face perception is concerned, the ERP's first face-specific negative component is the N170, which is thought to reflect structural encoding (i.e., the extraction of a perceptual representation of the face) (Eimer, 2000; Rossion et al., 1999). This means that by about 170 ms a detailed perceptual representation of the face is completed (Figure 8.2). Importantly, the abovementioned face-specific inversion effect (faces are harder to recognize with respect to objects when presented upside-down) modulates the N170 component and has been found to be particularly influenced by face rather than by object inversion. In the behavioral literature, the effects of inversion on N170 have been interpreted as a reflection of a disruption in configural processing (Maurer et al., 2002). When a face is perceived upside-down, information about the whole configuration and the spacing between the single elements is no longer available. Indeed, face processing may be related to a neural system that has evolved and become specialized in the processing of upright faces through everyday experience.

One important general question is whether there can be top-down influences arising from higher cognitive processes at this early stage of structural encoding. Is the structural encoding of faces cognitively penetrable from higher order processes, such as contextual or knowledge-based aspects? The way we perceive faces is carried out by perceptual processing but cannot be isolated from cognition. Therefore, top-down processes, for example face familiarity, might have an important role in modulating the processing of bottom-up information.

Psychological studies of face recognition have suggested a series of steps involving different cognitive processing stages. As mentioned above, Bruce and Young (1986) proposed that upright face processing is carried out in a hierarchical fashion by a number of relatively independent and sequential components, each of which performs specific computations such as structural encoding, familiarity decision, retrieval of semantic information and, finally, access to name generation. It has been argued that the N170 reflects structural perceptual encoding rather than higher order cognitive stages (Bentin et al., 1996). There is evidence, however, that the N170 component can be affected also by higher-level processes, such as degree of face familiarity (Caharel et al., 2002; Caharel, Courtay, Bernard, Lalonde, & Rebai, 2005), and priming (Jemel, Pisani, Calabria, Crommelink, & Bruyer, 2003; Jemel, Pisani, Rousselle, Crommelink, & Bruyer 2005). Recently, by investigating the effect of inversion and familiarity on face processing, we found that when familiarity is task-relevant, the N170 turns out to be cognitively penetrable and to interact with orientation (Marzi & Viggiano, 2007). Subjects performed a familiarity decision task while viewing famous or unknown faces that could be presented upright or inverted. The effect of inversion on the N170 was striking in particular for famous faces, for which a matching with the stored memory trace was presumably disrupted by inversion. The traditional view that visual processing proceeds in a bottom-up series of cognitive stages and that corresponding cortical regions analyze increasingly complex information has been challenged by recent models and findings that propose a simultaneous bottom-up and top-down flow of information (Miyashita & Hayashi, 2000). It is now widely documented that our conscious visual experience might be influenced by cognitive factors such as expectations, beliefs, and knowledge. Although the degree to which perceptual and structural processes might be affected by top-down information is still unclear, it is possible to suggest that also early stages of face perception might not always be considered “cognitively impenetrable”; this concept was used by Pylyshyn (1999) to support the view that cognitive influences operate on the outcome of visual processing and not on the visual process *per se*.

### *The Influence of Culture*

A very interesting question is whether or not structural encoding can be influenced by social factors, such as race. We have greater difficulty recognizing other-race faces than own-race faces. Individuals from diverse cultures report that members of other races all look alike. Numerous studies across different racial groups report a greater ability to discriminate among same-race rather than other-race faces (Feingold, 1914; Meissner & Brigham, 2001). It is generally agreed that the other-race effect results from the differential experience people have with same-race and other-race faces (Rhodes et al., 1989; Sangrigoli, Pallier, Argenti, Ventureyra, & de Schonen, 2005). An important issue is whether different visual cues are extracted from same-race and other-race faces. It has been proposed that the face-processing system is less sensitive to the spatial relations between features in other-race than in same-race faces (Rhodes et al., 1989). This effect appears to be mainly due to a loss of the ability to extract such spatial, or configural, relationships (Rhodes, Brake, & Atkinson, 1993). Further, it has been shown that same-race faces are perceived more holistically (as a whole) than other-race faces (Tanaka, Kiefer, & Bukach, 2004). Brain imaging studies have found in the fusiform gyrus greater response for own-race faces (Golby, Gabrieli, Chiao, & Eberhardt, 2001). Interestingly, other-race faces were found to elicit greater response in the amygdala, a subcortical structure critically involved in emotional processing (Phelps et al., 2000; Wheeler & Fiske, 2005). Furthermore, it has been shown that implicit negative attitudes to other-race faces correlated with activity in the amygdala even when the faces were masked from conscious recognition (Cunningham et al., 2004).

While neuroimaging data indicate that the activation of different cortical areas involved in face processing can be modulated by racial factors, the temporal dynamics of this processing remains unclear. It is important to determine if racial factors influence early perceptual stages of face processing, or if they affect later stages due to cognitive or emotional factors.

The influence of social factors on the neural processing of faces of other races has been investigated using ERPs (Walker et al., 2008). The results have shown that the structural encoding, indexed by N170, is affected by race. Interestingly, this effect was lower for participants with greater contact with other races. These findings suggest that experience with other races plays a crucial role in the way in which we encode own-race versus other-race faces beginning from early perceptual stages. The race effect on N170 elicited by other-race faces reflects the increased demands on the extraction of the configural features of the face during structural encoding. This study not only highlights early differential own-race versus other-race face processing, but also that these effects are dependent on social experiential factors. By the same token, the tracking of eye movements showed how culture might influence the way in which we perceive and process faces. Eye movements of Western Caucasian and East Asian observers were monitored while they learned, recognized, and categorized by race Western Caucasian and East Asian faces (Blais, Jack, Scheepers, Fiset, & Caldara, 2008). While Western Caucasian observers reproduced a scattered triangular pattern of fixations for faces of both races, East Asian observers focused more on the central region of the face. These results demonstrate that the strategy employed to extract visual information from faces differs across cultures. Western Caucasian observers consistently fixated on the eye region, and partially the mouth, whereas East Asian observers fixated more on the central region of the face.

Furthermore, Japanese people incorporate information from the social context to a greater extent than westerners when they have to judge emotion from facial expressions. This has recently been demonstrated by Masuda et al. (2008). In this study, participants viewed cartoons depicting a happy, sad, angry, or "neutral" (i.e., expressionless) person surrounded by other people expressing an emotion that was the same, or different, from the central person. The surrounding people's emotions influenced Japanese people's but not westerners' perceptions of the central person. These findings reflect differences in attention, which are indicated by eye-tracking data. That is, Japanese people looked at the surrounding people more than did westerners. These findings suggest that westerners see emotions as individual feelings, whereas Japanese see them as inseparable from the feelings of the group. All these findings clearly demonstrate that perceptual processes can be strongly influenced by external social and cultural influences. During face processing different kinds of information are extracted: perceptual and structural information, the global configuration of the face, the spatial relations between its parts, but also emotional and social cues. It is crucial to consider all these aspects and to understand how and when they interact to form a single representation. As far as the neural substrate of face perception is concerned, processing information gleaned from faces requires the integration of activity across a network of cortical regions. The face perception system must represent both the structural and invariant aspects and the more dynamic aspects that facilitate social communication.

Recent progress in functional brain imaging has allowed a tremendous improvement of our knowledge of the neural underpinnings of the human face recognition network (Ishai, 2008). This network includes regions in ventral visual cortex that subserve perceptual and recognition processes (Grill-Spector et al., 2004; Ishai et al., 2000; Kanwisher, McDermott, & Chun, 1997), the superior temporal sulcus, where changeable aspects of faces, such as eye gaze, and speech-related movements, are extracted (Hoffman & Haxby, 2000; Puce, Allison, Bentin, Gore, & McCarthy, 1998); emotion-related areas such as the amygdala, where, for example, trustworthiness is assessed (Winston, O'Doherty, Kilner, Perrett, & Dolan, 2002); and regions of the reward circuitry, including the orbitofrontal cortex, where facial beauty and sexual relevance are processed (Aharon et al., 2001; Ishai, 2007; Kranz & Ishai, 2006; O'Doherty et al., 2003) (Figure 8.3)

## EMOTIONAL CONTEXT IN FACE RECOGNITION

A face is not usually encountered as an isolated object, but instead appears within a context. The context in which faces are encoded is very important for a person's future ability to remember them.

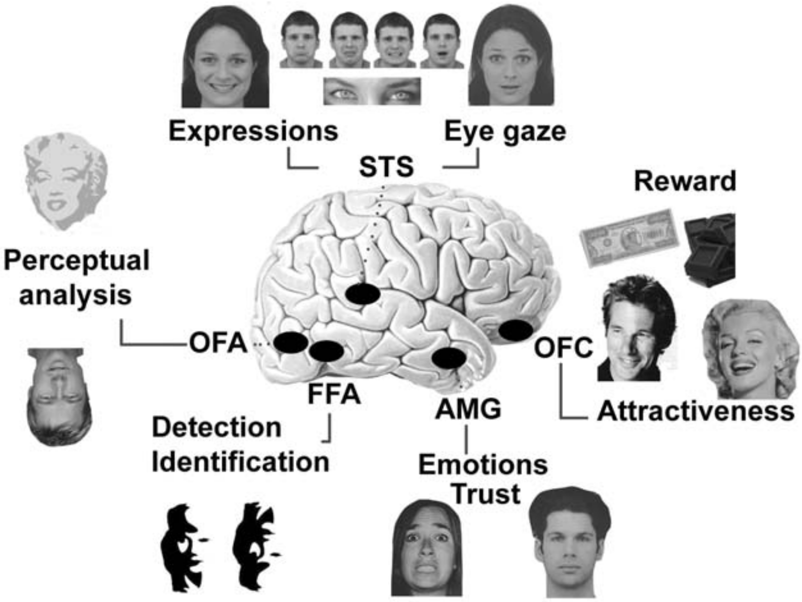

FIGURE 8.3 The many dimensions of faces and the neural areas involved in perceptual, emotional, and reward processing. OFC = orbitofrontal cortex, AMG = amygdala, FFA = fusiform face area, OFA = occipital face area, STS = superior temporal sulcus. Faces from Lundqvist et al., 1998.

There is no doubt that such contextual frames can strongly influence face perception in a top-down manner (Bar, 2004). A classic example is the "butcher-on-the-bus phenomenon," which has been investigated by Yovel and Paller (2004). This phenomenon occurs when an individual sees someone in an atypical context, and is experienced as a sense of familiarity while being unable to recall any specific detail about that person. The "butcher-on-the-bus phenomenon" clearly demonstrates that information that is received by the perceptual system can be influenced by what is already known about a stimulus. Thus, it is important to understand the effects of context on face processing, and how face perception interacts with high-level cognitive processing, and specifically with social and emotional processes.

What happens in our brain when we see a happy, fearful, sad or disgusted face? When and how might emotional cues extracted from faces influence face perception and recognition? What are the effects of emotional context, a negative or positive scene, information about a person or a particular expression, on the encoding of faces?

Humans are highly sensitive to emotional and social cues that provide important information about the feelings, focus of attention, and future behavior of others. In addition, our environment conveys a rich array of contextual information that influences how the brain encodes, categorizes and recognizes objects and people (Bar, 2004; Cox et al., 2004) in order to ensure that we respond to situations in an adaptive manner. Adaptive responses rely on the fast recognition of salient cues in our environment. For example, facial expressions are an important social signal and a very powerful cue in social interactions. Accurate perception and analysis of such cues is an important component of "social cognition" and facilitates appropriate behavior in complex social groups.

Contextual information might not only influence face perception, but the context of a prior encoding episode may also influence a person's later memory of a face. Indeed, it has been shown that faces associated with an emotion (e.g., a surprised, scared, or happy expression) were successively remembered better with respect to faces with neutral expressions (Shimamura, Ross, & Bennett, 2006). In this line of research, the effects of the power of a smile on memory processes have also been investigated as a function of brain activation. A smile probably serves to draw an observer's attention to a particular face, since a smiling face acts as a reward and provides the observer with positive feedback. In a recent functional magnetic resonance imaging (fMRI) study, Tsukiura and Cabeza (2008) investigated the effect of the potential power of a smile on memory processes. During encoding subjects were required to learn face–name associations and to rate facial expressions. During retrieval subjects were presented with both studied and new names and were asked to retrieve the facial expressions associated with the names. It was found that a smiling face enhanced memory. This finding indicates that there is an effect in brain regions associated with reward (e.g., the orbitofrontal cortex) and in brain regions associated with memory (e.g., the medial temporal lobes). Happy faces are better remembered than neutral faces due to reward signals processed by the orbitofrontal cortex which influences successful memory processes. These findings suggest that socially positive signals conveyed by happy faces may act as a reward and therefore facilitate face–name associations. Moreover, these results could reflect adaptive behavior given that it is advantageous to remember face–name associations for future social interactions.

The presence (or absence), and type, of contextual information might also have differential effects on face recognition depending on the valence of such information. That is, recognition (or recall) might be modulated by information associated with the face at encoding. A typical example of this is when we see a face in the newspaper and read about the negative or positive actions of the person. The kind of information associated with the face at encoding influences the creation of the memory representation of that face, which, in turn, modulates face recognition. So, if we view the same face outside of the context in which it was originally seen (e.g., in a neutral context), its recognition is influenced by the valence of the context within which it was originally associated. If faces that are associated with negative information are more quickly recognized, it would be interesting to know whether the context begins to have an effect at early or late stages of information processing.

These aspects have recently been investigated in our laboratory (Galli, Feurra,

& Viggiano, 2006) using ERPs in order to tap the time course of face recognition as a function of emotional context. This study aimed to investigate when (i.e., in which moment of the time course) and how the emotional context might influence subsequent recognition memory. Faces were presented either in a contextual frame or in isolation. Context faces were embedded in a newspaper article, the headline of which specified an action carried out by the actor depicted, which was emotionally positive ("Taxi-driver saves a child") or emotionally negative ("Hooligan rapes a girl"). The same faces, and new ones, were then successively presented in isolation (without any contextual cues) and participants were tested in an old/new task. It was found that the memory representation created at encoding endured until the successive exposure of the face. This represents an advantage in terms of response speed for faces associated with a negative context that had already started at earlier stages of information processing, as indexed by the enhancement of N170. From an evolutionary perspective, a processing advantage for negative stimuli may be considered adaptive – in terms of "chances of survival" – as it facilitates rapid responses to aversive events.

In a similar vein, Righart and deGelder (2005) recorded ERP for faces (fearful/neutral) embedded in scenes (fearful/neutral) while participants performed an orientation-decision task (face upright/inverted). Increased structural encoding, as indicated by the N170 response to faces, was found when faces were perceived in a fearful as opposed to a neutral context. This N170 response was further increased for fearful faces in a fearful context, possibly as a consequence of congruency. The N170 of faces, particularly fearful faces in a threatening context, may be increased in order to enhance structural encoding. In a potentially dangerous situation, it is important to quickly become aware of what is happening. Fearful faces and contexts may activate the amygdala and modulate activity in the fusiform gyrus (Surguladze et al., 2003), and may therefore influence face processing by enhancing the N170 amplitude. Enhanced N170 amplitudes for faces in fearful contexts may be related to enhanced encoding of identity, which may improve recognition memory for faces.

Converging evidence, therefore, demonstrates that emotional faces have a stronger impact at encoding than neutral ones. Negative faces (angry or fearful) as opposed to positive facial expressions have been shown to have a stronger impact at encoding. For instance, when a face is seen in a crowd, angry faces are detected faster than happy faces (Fox et al., 2000). From a sociobiological perspective the ability to recognize angry or threatening expressions more quickly is advantageous for survival. Nevertheless, faces with positive facial expressions, such as smiling faces, also signal very important information, and recognition of these can certainly facilitate relationships.

While a large of body of research has concentrated on facial expressions in general, the emotional response to the face of a person is also a very interesting aspect of socioemotional cognition. What is the relationship between recognition of an emotion that is transmitted by a facial expression and an emotion that is instead felt due to familiarity or an emotional tie with that person (e.g., relative or close friend)? A recent study has explored whether the same neural networks are involved in recognition of personally known and famous known faces (Gobbini, Leibenluft, Santiago, & Haxby, 2004). These two kinds of faces were both visually familiar to the observers; however, the personally familiar faces differed from the famous ones because observers had stronger emotional ties to them and more intimate knowledge about them. The results of this study showed that personally familiar faces elicited a stronger response than did famous familiar faces. This was evidenced in the anterior paracingulate cortex, posterior superior temporal sulcus, and posterior cingulate/precuneus. These results therefore imply that familiarity produces changes in the neural response to faces that goes beyond developing a visual memory for the appearance of a face. Perception of a familiar face activates a distributed network of brain structures that are implicated not only in visual familiarity but also in the knowledge about a person's nature, attitudes, and intentions as well as in the retrieval of episodic memories and in the affective reaction linked to that person. "Knowledge" about the other individual is spontaneously retrieved and seems to have a fundamental role in recognition of familiar others.

## *The Neural Underpinnings and Speed of Emotions*

Understanding how our inferences about people affect face perception is critical for building neural models of the processes that allow us to connect the visual appearance of a face with a rich contextual representation of a person. In an attempt to explore these processes, Adolphs (2001) proposed a model for recognition of emotion from facial expressions. He hypothesized that initial perception modulates activity in subcortical structures as well as in early visual cortices and that processing is very rapid, automatic, and coarse. In this model, information from subcortical structures is sent to the amygdala, where information about highly salient stimuli is extracted, and to early visual cortices responsible for the detection of specific facial features. Once early visual processing has provided a coarse representation of some aspects of the visual stimulus, more anterior regions, in the fusiform gyrus, are thought to construct a more detailed perceptual representation that depends on the configuration of the face. The superior temporal sulcus contains representations of the mouth and eye movements and changes in facial expression, while the amygdala and orbitofrontal cortex serve to connect a perceptual representation of facial expressions with our decoding of emotion (Figure 8.3). Although there is now a large body of evidence that face identity is processed in the fusiform face area and that facial expressions are analyzed in the amygdala and superior temporal sulcus, there is also increasing evidence that these two aspects of face recognition might not (as previously proposed by cognitive models) be entirely independent, and separately implemented, in these different regions (for a review see Pourtois & Vuilleumier, 2006). These findings suggest that different regions in the face recognition network interact dynamically with each other

What about the speed of emotional processing? In line with Adolphs's model, Eimer and Holmes (2007, but see also Vuilleumier & Pourtois, 2007) highlighted evidence in a recent review for the existence of a complex, interconnected network of brain structures that are responsible for analyzing emotional faces, and delineated the temporal dynamics of emotional face perception. Emotional faces were found to trigger an increased ERP activation relative to neutral faces. The onset of this emotional expression effect was found to be remarkably early, ranging from 120 to 180 ms post-stimulus (Eimer & Holmes, 2002, 2007). The emotional value of facial expressions could be reflected in very rapid evaluations of emotion. Indeed, single-neuron responses to emotional faces have been found in the human prefrontal cortex at very short latencies of 120–160 ms (Kawasaki et al., 2001). Moreover, Tsao, Schweers, Moeller, and Freiwald (2008) found that patches of face-selective cortex in the macaque frontal lobe were responsive to emotional faces. Prefrontal responses, which involve the orbitofrontal cortex, are responsible for rapid and coarse categorization of emotion and might modulate visual information processing in other brain regions via feedback to other temporal cortices. The prefrontal cortex plays a role in linking the perceptual representation of stimuli to the guidance of behavior, including the flexible execution of strategies for obtaining rewards. In particular, the amygdala and orbitofrontal cortex receive highly processed visual inputs from the visual area. These regions have strong interconnections with visual sensory areas which are well positioned to tune perceptual processing in the sensory cortex based on stimulus evaluation (Pessoa, 2008).

## FACIAL BEAUTY AND TRUST

The human face appears to play a key role in signaling social and emotional cues, and people usually form rapid and strong impressions on the basis of someone's facial appearance. Therefore, facial signals could have a substantial influence on how a person evaluates and behaves towards another person in social interactions.

In the past few decades there has been a significant improvement in our understanding of the nature of the relationships between mind, brain, and behavior. A new approach in cognitive neuroscience has recently emerged which no longer conceptualizes people's brains as strictly isolated units but instead as minds that interact with other minds. In line with this approach, social cognitive neuroscience has now begun to concentrate on questions such as, how do our brains handle all of the rapidly incoming information in social interactions? What happens in our brain when we see an attractive person? And what makes us trust some people and not others? These questions form much of the focus of the following section. FMRI tells us what is active in the brain, and ERPs tell us when this activity takes place. In order to understand the cortical networks that are active in social cognition, a multimodal integration of ERP and neuroimaging studies will be considered.

### *Facial Beauty*

Facial attractiveness plays a key role in human social and affective behavior. Facial attractiveness has a strong impact on our judgments about people and on how we treat them. Given the importance of attractiveness in our everyday interactions, many research areas including psychology, neuroscience, and biology have sought to reach agreement about which physical features make a face most attractive.

What makes a face attractive and why do we have the preferences we do? Such research has shown that averageness, symmetry, sexual dimorphism, a pleasant expression, good grooming, and youthfulness enhance judgments of attractiveness (Etcoff, 1999; Rhodes, 2007; Rhodes et al., 2006; Thornhill & Gangestad, 1999). The averageness of faces refers to how closely they resemble the majority of other faces within a population. Perhaps surprisingly, average rather than distinctive faces are proposed to be attractive because facial structures that are close to the population average are associated with developmental stability and genetic diversity, which may increase disease resistance (Thornhill & Gangestad, 1993). Symmetry is considered to be important for attractiveness because it could also indicate potential mate quality (Gangestad & Thornhill, 1997). Sexual dimorphism, a preference for masculinity in male faces and femininity in female faces, also has a fundamental role in signaling differences in mate quality. Female faces with a feminine shape, typified by large eyes and pronounced cheekbones (Penton-Voak et al., 2001), are judged to be highly attractive (Perrett et al. 1998); the same holds true for male faces with masculine shapes, a wide lower face and pronounced brow. Together, the abovementioned factors are good candidates for biologically based standards of beauty. The long-held view that our preferences reflect arbitrary standards of beauty dictated by culture has been challenged by the emergence of early developmental preferences for attractive faces and cross-cultural agreement on attractiveness. Specifically, a sociobiological perspective on attractiveness suggests that it has an evolutionary basis and is an indicator of reproductive fitness (Thornhill & Gangestad, 1999). While it is commonly thought that beauty is in the eye of the beholder, there is now substantial evidence that facial beauty is not only a matter of personal preference but that there is high agreement among individuals on who is beautiful.

Nevertheless, little is known about how the human brain represents facial attractiveness. Research on facial attractiveness has only recently begun to consider the brain mechanisms that underpin attractiveness judgments. Neuroimaging studies have shed light on the regions that are responsive to attractiveness. Viewing images of attractive faces increases activity in brain regions that are known to be important for processing food, money, and sexual rewards (Figure 8.3) (O'Doherty, 2007). Although the exact brain systems involved are somewhat variable, typically reward- and emotion-related areas such as the orbitofrontal cortex, basal ganglia, and amygdala have been shown to be responsive to facial attractiveness (Aharon et al., 2001; Kampe, Frith, Dolan, & Frith, 2001; Kranz & Ishai, 2006; Nakamura et al., 1998; O'Doherty et al., 2003). Attractive faces may be considered to be a type of reward and the reward value of different stimuli categories is processed by the orbitofrontal cortex. Notably, smiling faces enhance evaluations of attractiveness and cortical responses in reward-related areas. Interestingly, unattractive faces are also represented in the brain. While the medial orbitofrontal cortex is enhanced for attractiveness, the lateral orbitofrontal cortex instead is more responsive to unattractive faces (Winston et al., 2007). This is in line with evidence that the medial orbitofrontal cortex responds to rewards while the lateral orbitofrontal cortex responds to punishments. Winston et al. (2007) found that neural responses to facial attractiveness are automatically engaged even if subjects are performing an unrelated task, such as judgments about age. This shows that these responses are automatic and not enhanced as a function of attending to relevant features.

When forming preferences about faces, our visual system has to integrate physical and social cues, thus integrating perceptual, structural, and socioemotional aspects. The ability to recognize and to behave with respect to attractive cues gleaned from attractive faces probably requires a distributed neural network that connects perception to motivation, emotion, and adaptive behavior (Adolphs, 2001).

Unlike the social signals of gaze direction or facial expressions, attractiveness is based more on temporally invariant rather than dynamic aspects of facial features. In this respect facial attractiveness may engage processing demands that are similar to those engaged for identity and gender and might therefore require the contribution of the fusiform face area. A recent study (Barton, 2008) showed that prosopagnosic patients, whose core deficit is an impairment in processing facial identity, were also impaired in perceiving facial attractiveness, which provides further support for the contribution of face-specific visual areas.

Among the numerous socially relevant dimensions extracted from faces, facial attractiveness has a profound influence on how we interact with people we meet for the first time. Formation of preferences is a fundamental evaluative mechanism that precedes many other cognitive processes, such as recognition memory processes. It could be that evaluations of attractiveness during face encoding might influence subsequent recognition memory (the judgment that a stimulus event has previously been experienced). Specifically, information about attractiveness might be coded and integrated in memory representation. To explore this issue, we (Marzi & Viggiano, in press) recently sought to investigate the influence of attractiveness on the electrophysiological correlates of recognition memory. Although neuroimaging studies have begun to uncover the neural underpinnings of attractiveness judgments, the temporal dynamics of this processing is still far from settled. Using ERPs, we investigated the influence of different degrees of facial attractiveness on memory-related processes. Research on the cognitive neuroscience of emotion and memory has provided evidence that emotion can enhance the formation and recollection of episodic memory (LeDoux, 2000). Memory processes can also be enhanced by the encoding of reward stimuli (Tsukiura & Cabeza, 2008). We were intrigued to know whether a very attractive face would enhance encoding and subsequent retrieval.

Considering that very attractive faces are stimuli that reward us, we hypothesized that through the activation of orbitofrontal cortex, which is connected with visual cortices, fusiform face area (Fairhall & Ishai, 2006) and with the medial temporal lobe, there could be an enhancement both at encoding and recognition. Subjects rated faces for attractiveness (on a four-point scale ranging from very attractive to unattractive) and then carried out an old/new recognition test. We found interesting data showing that beauty, especially very attractive faces, interacts with memory processes beginning from very early ERP latencies and that it affects familiarity-based recognition. An interesting result was that the responses triggered by very attractive faces were enhanced in males when they viewed female faces. Attractive faces of the opposite sex probably have different reward values for men and women (Cloutier, Heatherton, Whalen, & Kelley, 2008). Notably, sexual preferences modulate neural responses to relevant stimuli as found by Kranz and Ishai (2006). It has been proposed that the rewarding, adaptive value of an attractive face can be dissociated from its aesthetic value. An attractive opposite-sex face may signal that a potential sexual partner has healthy genes, whereas an attractive same-sex face obviously cannot have such reproductive benefits (Senior, 2003). While men focused on sexual appeal in their evaluations, women possibly based their judgments more on aesthetic aspects.

The extraction of information from social cues, such as facial expressions or eye gaze, is also very important for face attractiveness evaluation. Attractive faces are more rewarding when they are smiling than when they are shown with neutral expressions. Faces are also more rewarding when they are shown with a direct gaze focusing on the viewer than when they are shown with an averted gaze (Jones et al., 2006). This is because someone looking at you or smiling at you indicates that they are probably interested in engaging in social interaction with you. These findings suggest that facial attractiveness is not only influenced by physical facial features but that it also can be influenced by how interested a person appears to be in you. Gaze direction and smiling influence preferences for physical beauty.

These findings demonstrate that people have to integrate many different cues when they read faces and expressions, and judge gaze direction and physical attractiveness.

### Deciding Whom to Invite on a Date

Affective judgments about face attractiveness are extremely important in this kind of personal choice. Faces are attractive in that they draw us into relationships. The appeal of a face, however, is partly determined by what we seek in it. What is appealing about a face can change, based on social context and expectations. Since there are different types of attractiveness, measuring instruments that differentiate these subtypes should ideally be employed. In particular, it would be interesting to include questions in face attractiveness research that tap different aspects of attractiveness such as with whom the perceiver would want to have a long-term vs. a short-term mate, have sex, or form friendships. We know that people can judge a lot about a person from their face (Figure 8.3), including things such as health and even some personality traits such as introversion. It has been shown that women prefer men with more feminine faces when seeking a long-term mate, probably because these males have the traits of good fathers (Pound et al., 2009). Recently, Little and Jones (2006) discovered that people are also sensitive to subtle facial signals about the type of romantic relationships that others might enjoy. Men with traits perceived as more virile, with square jaws, large noses and small eyes, were more regularly imagined by woman to be chasing short-term gratification. This study showed how initial impressions may be part of how we assess potential mates or potential rivals. Women prefer more masculine male faces for short-term relationships and more feminine-faced males for long-term relations.

Social aspects can also influence face preference, and several studies are now focusing on this topic. Female observers' preferences for men were stronger when they viewed other women smiling at male faces than when they viewed women with neutral (i.e., relatively negative) expressions looking at the men's faces (Jones et al., 2007). Moreover, studies conducted on female choice showed that when females observe another female paired with one of two males, they subsequently prefer the paired male over the unpaired male.

Recently, cognitive neuroscientists have also begun to study the neural basis of romantic love. Using fMRI, it has been shown that viewing photographs of a beloved person increases activity in reward-related brain areas and suppresses the activity of neural networks associated with negative emotions and critical social assessment of others (Bartels & Zeki, 2000). Romantic love has also been investigated in an ERP study. Participants who were in love viewed faces of their beloved, a friend, and unknown beautiful faces. Results showed an enhanced late positive potential for the beloved, reflecting a strong emotional response and motivated attention (Langeslag, Jansma, Franken, & Van Strien, 2007).

On the whole, all these findings bring us a little closer to understanding the neural underpinnings and perceptual processes involved in our everyday interactions.

## *Should I Trust You?*

A hundred milliseconds of exposure to a neutral face is sufficient for people to make a variety of trait judgments such as trustworthiness, competence and aggressiveness (Willis & Todorov, 2006), and the time exposure can be even shorter for some of these judgments (Bar, Neta, & Linz, 2006). Deciding whether an unfamiliar person is trustworthy is one of the most important decisions in social environments. In many situations individuals have to decide whether another person is someone to approach, avoid or trust. A large body of cognitive neuroscience research on face perception focuses either on face categorization and recognition of facial identity or on recognition of the expressions of emotions. Recently, cognitive neuroscience has also begun to investigate perceptions about trustworthiness using brain imaging studies.

The power of event-related functional magnetic imaging was used to study the brain areas associated with social judgments of trustworthiness. Results revealed that the amygdala showed significantly higher levels of activation when subjects viewed faces that they later rated as "most untrustworthy" than when they viewed those rated as "trustworthy", irrespective of whether an explicit judgment was required during the scan (Figure 8.2) (Winston, Strange, O'Doherty, & Dolan, 2002). These findings provide support for a model of social cognition in which regions of the visual cortex process perceptual information, and the amygdala and orbitofrontal cortex then orchestrate emotional reactions to socially relevant visual stimuli. The observed patterns of activation suggest that the amygdala contributes to rapid and automatic emotional responses, whereas the orbitofrontal cortex only contributes to emotional responses in the context of a particular conscious evaluation.

It is plausible that viewing people who look untrustworthy may produce emotional responses and changes in the feelings of the perceiver, and that such feelings might influence judgments about trust. Developmental prosopagnosics who have severe facial identity processing impairments can make normal trustworthiness judgments from faces (Todorov & Duchaine, 2008). Further studies on prosopagnosic patients are necessary because this impairment provides a unique window into specialized face processes and their relationship to the processing of emotional and social cues.

People automatically evaluate faces on multiple trait dimensions and these evaluations predict important social outcomes (Ballew & Todorov, 2007). It has been shown that rapid judgments of competence based solely on the facial appearance of candidates predicted the outcomes of one of the most important elections in the United States. Rapid, implicit judgments of competence based solely on facial appearance and made after as little as 100 ms of exposure to the faces of the winner and the runner-up have been shown to predict election outcomes.

In line with this study, Little, Cohen, Jones, and Belsky (2007) examined the role of visual appearance in voting for national leaders, a type of judgment in which physical appearance might be expected to be less important, given the wealth of information available about the participants. The authors of this study also examined the effects of context (wartime vs. peacetime) on voting for different faces. To examine the interaction between face shape and wartime/peacetime context, they used a pair of manipulated faces based on politicians and faces manipulated for masculinity, which were considered to show dominance vs. prosocial traits, as such traits appear likely to have different worth under wartime and peacetime conditions. Their results showed that facial appearance has important effects on choice of leader. Differences in facial shape alone between candidates can predict who wins or loses in an election. Changing context from wartime to peacetime can affect the type of change that is voted. Even for decisions based on critical and objective evaluations of a variety of information, we may in fact be influenced by relatively simple, unconscious stereotypical processes.

Deciding if a person can be a friend or a foe has important implications in social interactions. In a recent experiment (Van't Wout & Sanfey, 2008) it was demonstrated that implicit processing of social cues and trustworthiness had a reliable effect on decisions made in the Trust Game. Namely, participants chose to invest more money with partners who had higher trustworthiness ratings.

Participants played a Trust Game with 79 hypothetical partners who were previously rated on subjective trustworthiness. In each game, participants made a decision about how much to trust their partner, as measured by how much money they invested with that partner, with no guarantee of return. As predicted, people invested more money in partners who were subjectively rated as more trustworthy. Moreover, the relationship with the amount of money offered seemed to be stronger for trustworthy compared to untrustworthy faces. Overall, these data indicate that perceived trustworthiness is a strong and important social cue that influences decision-making.

Recognition of socially relevant information, evaluation of attractive faces and judgments about trustworthiness require neural networks that connect the perception of social signals to motivation, emotion, and adaptive behavior. These neural mechanisms include specific regions in higher-order sensory cortices, the amygdala, ventral striatum, and orbitofrontal cortex. Specifically, the orbitofrontal cortex along with the amygdala and temporal cortex form part of the so-called "Social Brain," a neural network dedicated to social cognition that allows us to interact with others.

## CONCLUSION

In conclusion, studying face perception allows a greater understanding of the key cognitive processes and neural systems involved in social cognition. The complexity of human social behavior reflects the interactions of several social factors and relative neural systems involved in the perception of social signals. Faces, as multidimensional stimuli, provide distinctive information about a person's identity and gender, as well as social signals related to emotions. Notably, the information about identity and emotions is linked together when we form impressions about others. The integration of structural and emotional aspects with information retrieved from memory allows increasingly complex judgments about different face dimensions such as attractiveness, trustworthiness, approachability and enables us to understand emotions and intentions of other people. What is still unknown is how these various dimensions are coded and how they are integrated into a single representation.

Additionally, given the complexity of such a process, it is challenging to draw an exhaustive sketch of the interconnections between the neuroanatomical structures underlying face perception. Overall, fMRI and ERP results demonstrate that social face perception is a complex process that cannot be related to a single neural event taking place in a single brain region, but rather implicates an interactive network with distributed activity in time and space, although the exact role and dynamics of these different brain areas and of the different cognitive processes involved are still far from settled.

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# 9

# Embodied Simulation: A Conduit for Converting Seeing into Perceiving

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Flipping through the content of Goldstein's (2007) *Sensation and Perception* popular textbook for undergraduate psychology courses, one finds nine chapters on visual perception. In them, one can read about the Nobel Prize winning discovery of orientation and ocular dominance columns (Hubel & Wiesel, 1959) and about the dorsal ("what") and ventral ("where") pathways in the brain (Ungerleider & Mishkin, 1982), as well as learn many detailed facts about basic shape, color, and motion processing. After reading this text, an undergraduate student may conclude that they now know all there is to know about visual perception. However, this undergraduate would have mistakenly equated seeing with perceiving. In fact, in an often-repeated anecdote, Francis Crick jokingly complained that modern researchers are so focused on the lower vision that they stopped caring about what people actually perceive.

There is a famous philosophical puzzle that speaks to the dissociation of pure seeing (arguably an end result of the well-studied visual pathways originating in the retina and culminating in the inferior temporal and posterior parietal cortices) and perceiving (arguably an end result of more complex processing involving systems spread throughout the entire brain). The question is this. Imagine Mary, who is a color-blind. But Mary is a color-vision specialist. She is an expert on all aspects of color vision: the physics of light waves; the absorption and reflectance properties of surfaces; the physiology of the eyeball; the function of the rods and cones, optic nerve, and color processing areas of the brain. However, Mary herself has never experienced color. So, does she really know what it is like to see red? Jackson (1986) proposed that the theory–experience gap would preclude Mary from understanding the internal qualia, or mental content, of the experience of seeing red.

This theoretical scenario highlights the importance of an individual's own experiences in visual perception of even the most basic property. This is the main tenet of embodied perception, which claims that the process of perceiving an object, person, or scene relies on the same neural systems that process the experience of what is observed. Though embodied perception can be demonstrated with elementary quale (e.g., color) that may require at least an implicit representation of an embodied "self" to experience the perception, it's perhaps more intuitive to consider its uses in social perception – the visual perception of another person. It is here that the insufficiency of Goldstein's portrayal of visual perception is most clearly demonstrated.

Thus, despite its mysterious absence from basic textbooks on perception, we will suggest herein that our own embodied knowledge critically contributes to that visual perception of social stimuli. Further, we will suggest that perception is more than simply seeing; it is understanding the meaning of what is seen. Though some stimuli such as inanimate objects can be, and are likely, processed in a disembodied fashion, embodied processing most clearly contributes to the perception of social stimuli. Whereas disembodied processes, for example, tell you that the man in front of you just tripped and now his face is turning red, it is embodied processing that allows you to understand his embarrassment. And although the visual system will tell you, for example, that the woman at the bar is moving her hand through her hair and moving her mouth in an upward direction, it is embodied processing that allows you to understand that she is flirting with you.

Clearly this type of perception (social perception) goes well beyond the capacity of basic visual processing. In this chapter we will discuss what is meant by embodied processing. We will also discuss behavioral, electrophysiological, and neuroimaging evidence for embodied perception. We will conclude by discussing why simulation and mirroring processes are critical for social perception and what deficits arise when embodied perception goes awry.

## EMBODIED AND DISEMBODIED THEORIES OF PERCEPTION

A thorough review of the history and debates between embodied (often referred to as modal) and disembodied (often referred to as amodal) approaches to perception is beyond the scope of this chapter. Still, it is helpful to briefly introduce some basic ideas and conceptual distinctions. The ideas of embodied cognition have a long history in philosophy (Heidegger, 1962; Merleau-Ponty, 1963). Yet, until recently, psychological theories of perception have been largely disembodied. The proponents of disembodied perception argue that the goal of vision is to create a detailed model of the world in front of the perceiver (Marr, 1982). The creation of this final model occurs via a set of fairly encapsulated, modular, hierarchical, mostly bottom-up processes (for a critique, see Churchland, Ramachandran, & Sejnowski, 1994). Further, to interact with higher cognitive processes, such as thought and language, the visual representation must be "transduced" into amodal (digital-like) symbols that are separate from its sensory origins and bear no analogical relationship to the experienced event (for a review see Fodor, 1975).

The embodiment theories arose as an alternative to such symbolic, hierarchical accounts of information processing. Their proponents argue that visual processing, language, thought, and behavior are intrinsically intertwined (for a review see Barsalou, 1999, 2008). Gibson, an early embodied theorist, writes: "we must perceive in order to move, but we must also move in order to perceive" (Gibson, 1979, p. 223). Thus, low-order as well as high-order processing relies on modalities – perceptual, somatosensory, introceptive, and motor resources (Barsalou, 1999, 2008; Glenberg & Robinson, 2000; Prinz, 2002; Wilson, 2002). In this account, modalities are a critical part of "online" cognition (perceiving and understanding the present stimulus) as well as "offline" cognition (thinking about the absent stimulus). A notion shared by many embodiment theories is that recruitment of somatosensory resources often involves "embodied simulation" (Gallese, 2003). "Simulation" can be thought of as the offline projection of a perceived stimulus back onto the observer's own motor, cognitive, and emotional representations. Thus, the mechanisms by which we understand states of others overlap with mechanisms by which we experience those states ourselves.

It is now accepted by most that the typically developing human brain is capable of both embodied and disembodied perception. We will argue that specific properties of stimuli determine whether it will be processed in an embodied or disembodied fashion. Specifically, objects that offer an opportunity for interaction (either social or physical) will likely be processed in an embodied way, whereas those that do not offer an opportunity for interaction will be processed in a disembodied fashion. The concept of "opportunity for interaction" is most aptly described in the writings of Gibson in his *The Ecological Approach to Visual Perception* (1979). Gibson writes: "Each thing says what it is . . . a fruit says Eat me; water says Drink me; and woman says Love me . . . the postbox invites the mailing of a letter, the handle wants to be grasped, all things tell us what to do with them" (Gibson, 1979, p. 138). Gibson's concept of "affordances" or the concept of the perception of what a stimulus offers for interaction set the stage for embodied theories of perception. However, how can one perceive things that do not offer any opportunity for interaction?

Though this review highlights the benefits of embodied perception, especially as it pertains to social stimuli, it is clear that the perception of certain stimuli is inherently disembodied. Specifically, certain stimuli, such as sunsets, do not offer any opportunity for physical interaction and thus are unlikely to involve embodied processes at the stage of construing a visual percept, though perhaps not an emotional response that makes the red colors of sunsets "impressive", or "haunting" (Slater, 1997). Additionally, certain inanimate objects (such as components of a complex machine), which do not afford direct interaction, are thought to be processed in a disembodied fashion (Martin & Weisberg, 2003). Thus, in this chapter, we do not claim that *all* perception is embodied, but rather that embodiment provides a strategy for perception of socially relevant animate stimuli that allows the observer to go beyond just a representation of basic physical attributes of the stimulus.

Embodied cognition is thought to be most involved in processing of two classes of stimuli: inanimate objects that are associated with specific actions by the perceiver, and, more importantly, animate stimuli. Note that the actions of mechanical objects can be successfully predicted based on their physical characteristics and physical laws – using processing sometimes termed "systemizing"

(Baron-Cohen, 2002). However, this processing is not sufficient for understanding animate stimuli, and especially human behaviors. After all, those behaviors are motivated by internal states that typically do not follow mechanistically predictable patterns – requiring processing sometimes called "empathizing" (Baron-Cohen, 2002). Thus, many researchers have proposed an embodied account of human perception (Barsalou, 1999; Gallagher & Meltzoff, 1996; Gallese, 2001; Gallese & Goldman, 1998; Meltzoff & Moore, 1995). Though each researcher uses his or her own terminology, all generally claim that the understanding of human actions and internal states relies on both the capacity of the observer to perceive other humans as "like me" and the capacity to simulate the observed actions and internal states of other humans within the observer's own motor, cognitive, and emotional representations.

This embodied account proposes that when typically developing individuals perceive another person in a certain situation, they will automatically and unconsciously project that perception back onto their own motor, cognitive, and emotional representations in order to run an offline simulation (Gallese, 2003). This offline simulation, in turn, allows individuals to create an embodied understanding of the observed person's behaviors, thoughts, and feelings.

To understand why certain inanimate objects also result in embodied processing, we return to Gibson's pioneering work where he writes: "The observer who does not move, but only stands and looks is not behaving at the moment, it is true, but he cannot help seeing the affordances for behavior in whatever he looks at" (Gibson, 1979, p. 223). Through embodied perception, certain objects that the observer is capable of interacting with will automatically activate the motor representation associated with that interaction, thus facilitating the appropriate behavioral response to the perceived object. Indeed, there is direct neurophysiological evidence for this. A certain class of neurons, "canonical neurons" (see below), will fire not only when a monkey or a person reaches out to grasp an object, but also on the visual perception of that object.

In summary, we suggest that the world is perceived through two complementary mechanisms. Disembodied perception is used when observing inanimate objects and scenes that do not allow direct interaction, while embodied perception is utilized for perceiving animate stimuli and objects that are associated with specific actions. Thus, as it pertains to social stimuli, the embodied account proposes that when observers perceive a social scene, they will automatically and largely unconsciously project that perception back onto their own motor, cognitive, and emotional representations in order to run a simulation (Gallese, 2003). This simulation, in turn, allows the observer to create an embodied understanding of the observed person's behaviors, thoughts, and feelings (Barsalou, 1999, 2008).

## EVIDENCE FOR EMBODIED PERCEPTION

Thus far, this chapter has presented theoretical and philosophical considerations motivating the embodied account of social perception. In this section we will describe some empirical evidence for embodied processing. The embodied account's claim that perception and experience share underlying representations makes two related predictions. First, perception and action should share an underlying neural circuitry. Second, perception should result in matching responses in the observer.

Behavioral investigations, as early as the informal observations performed by Darwin, indicate that when individuals are in the presence of others, the observer tends to synchronize his or her movements to match those of the others (Condon & Ogston, 1967; Darwin, 1872/1965; Kendon, 1970). Early behavioral studies show that mothers tend to open their mouths when their infant is feeding (O'Toole and Dubin, 1968) and infants mimic some mouth movements of the adults around them (Meltzoff and Moore, 1977). Imitation, however, is not limited to mouth movements. Specifically, people tend to mimic others' gestures and body postures (Chartrand & Bargh, 1999) and emotional facial expressions (Dimberg, 1982; Dimberg, Thunberg, & Elmehed, 2000; Wallbott, 1991).

In addition to behavioral studies, the existence of embodied processes during visual perception is substantiated by electrophysiological and neuroimaging studies that have recorded neural responses during visual perception and found activations in motor and somatosensory regions during visual perception of human actions and sensations. These studies have extended the knowledge beyond what behavioral studies are capable of and have given insight into the brain basis of embodied perception.

Electroencephalography (EEG) studies from as early as 1954 demonstrated neural activity in the region of sensorimotor cortex when nonmoving subjects watched other individuals performing specific actions. To investigate changes in brain activity, French researchers Gastaut and Bert (1954) recorded EEG activity while subjects performed actions as well as while they were presented with visual stimuli. Gastaut (1951) had previously reported that oscillations recorded over the sensorimotor region of the brain were reduced in amplitude when subjects performed an action or simply shifted their posture. Just 3 years later, Gastaut and Bert (1954) found that these same oscillations were also reduced when subjects identified themselves with an active person represented on a screen; for example, when they viewed a film of a boxing match. It is currently thought that suppression of this rhythm represents increased activity in the neural networks located in the sensorimotor region (Andrew & Pfurtscheller, 1997). Thus, as early as 1954, there was neurological evidence that the visual observation of actions in others activates neural systems in the observers' sensorimotor systems even when the observer himself is sitting completely still (Gastaut & Bert, 1954).

Over the past several years, other techniques have also been successful in identifying activity in the area of the sensorimotor cortex during action observation. Hari and colleagues have successfully used magnetoencephalography (MEG – an imaging technique measuring the magnetic fields produced by electrical activity in the brain) to measure the activity of the motor cortex following stimulation of the median nerve in the forearm (Avikainen, Forss, & Hari, 2002; Hari et al., 1998). As predicted by the shared system idea, MEG oscillations over sensorimotor cortex (an index of activity) showed a significant reduction during both action execution and action observation.

Additional support for the shared system for execution and observation comes from findings that readiness potential (marker of motor preparation recorded over the sensorimotor cortex) occurs prior to the actual movement as well as during observed actions (Kilner, Vargas, Duval, Blakemore, & Sirigu, 2004). Furthermore, when the nature and onset of action is predictable, the occurrence of the readiness potential precedes the observed movement's onset. Kilner et al. (2004) proposed that this type of timing might allow the observer not only to react to others' actions but also to anticipate actions that will be performed in the near future.

Though temporarily precise electrophysiological recordings from the scalp give us broad estimates of neural systems involved in certain behaviors, their spatial resolution is limited for exact localization of neural mechanisms. The ideal technique for such research is to record directly from individual neurons in awake human volunteers. However, such an opportunity is rarely available to researchers (though a recently published study that did just that will be discussed later in this section). Alternatively, animal studies on closely related species can be quite informative for such an investigation. The macaque monkey has been the prime subject for investigation of the mechanisms underlying action observation and execution.

The most relevant and well-known discovery in macaque single-unit electrophysiology research was made by Giacomo Rizzolatti and his colleagues (Di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992; Fogassi, Gallese, Fadiga, & Rizzolatti, 1998; Gallese, Fogassi, Fadiga, & Rizzolatti, 2002). While studying the premotor cortex (a motor planning region of the brain) in the macaque, they came across a system of neurons that responded not only when the monkey performed an action but also when the monkey watched the researcher perform a similar action (Di Pellegrino et al., 1992). The team named this system of neurons the *mirror neuron system (MNS)* because it appeared that the observed action was mirrored or simulated within the monkey's own motor system. In addition to the original mirror neurons found in the macaque's premotor cortex, neurons in the inferior portion of the parietal cortex have also been found to have mirror properties (Fogassi et al., 1998; Gallese et al., 2002).

The first attempt to localize the human MNS was a study by Fadiga, Fogassi, Pavesi, and Rizzolati (1995). Using transcranial magnetic stimulation (TMS – a noninvasive method to excite neurons in the brain), these researchers investigated whether the premotor cortex in humans responded when the participants watched others' actions. It was determined, on the basis of anatomical cytoarchitecture, that the human homolog to the region where mirror neurons were identified in the macaque is Brodmann's area 44/45, also known as Broca's area. Fadiga and colleagues found that TMS applied over Broca's area (temporarily activating this region) resulted in greater muscle activity in the observer's fingers when the subject observed another person moving, as compared with a baseline rest condition.

Subsequent to this neuromagnetic study work, several researchers conducted similar studies using positron emission tomography (PET, which measures glucose absorption in the brain) and functional magnetic resonance imaging (fMRI, which measures blood flow in the brain). Essentially, these studies showed selective activity in Broca's area and the inferior portion of the parietal cortex when subjects watched human actions (Decety et al., 1997; Iacoboni et al., 1999). Further, this activity, similar to the macaque correlate, was somatotopically distributed (corresponding to specific body parts) in both premotor and parietal regions (Buccino et al., 2001).

Consistent with the proposals from embodied cognition, human mirror neurons appear to be selective to actions within the observer's motor repertoire (actions the observer is able to perform). In other words, if the observer is unable to match the observed action to a motor representation within his or her own system, the mirror neurons will not respond (Buccino et al., 2004; Stevens, Fonlupt, Shiffrar, & Decety, 2000). Interestingly, the individual need not be familiar or skilled at the action but only physically capable of performing it. For example, actions such as grasping and biting, which humans share with other primates, will activate the human MNS whether the observed action is performed by a human or a macaque. However, observing a dog barking, which is not part of the human motor repertoire, does not activate this system but rather is processed in lower level perceptual systems (Buccino et al., 2004).

Furthermore, actions that are part of the human motor repertoire but are not familiar will activate the MNS less than actions that are familiar to the observer. This property was demonstrated in a study conducted by Calvo-Merino, Glaser, Grezes, Passingham, and Haggard (2005). These researchers recorded fMRI data from expert dancers and found increased activity to the observation of others performing familiar styles of dance movements, as compared with unfamiliar styles matched for low-level visuomotor properties.

Though the majority of studies on the MNS in humans have utilized imaging technology, a recent study took advantage of a rare opportunity to record from individual neurons directly from the cortex in patients undergoing surgery for intractable epilepsy. Mukamel, Ekstrom, Kaplan, Iacobini, and Fried (2007) recorded the activity of 286 neurons in the central region of the frontal lobe while patients were instructed either to observe short video clips depicting a hand grasping a cup (precision grip or whole-hand prehension) or to actually grasp a cup in front of them. Patients were also instructed to either view still images of facial gestures (smiling or frowning) or to perform these facial gestures themselves. Out of the 286 neurons recorded, 12% responded during both the observation and execution conditions. This study suggests that a portion of neurons in motor cortices are active during the observation of human actions. A limitation of this study is that these patients had epilepsy, and thus it is unclear whether the findings can be generalized to healthy brains. Additionally, the specific regions that the team was able to record from were dictated by the neurosurgeon based on the specific patient's epilepsy. Thus, the researchers did not have control over which of the neurons provided recordings.

## PURPOSE OF EMBODIED PERCEPTION

The previous section explored the behavioral, electrophysiological, and neuroimaging data supporting the existence of embodied processes during visual perception. Though we would argue that the occurrence of spontaneous behavioral mimicry and activations of motor and sensory regions of cortex during visual perception of others suggests that embodied processes play a critical role in perception, other theories may also account for this mirroring response. The earliest explanation for spontaneous mimicry was proposed by William James (1890), who suggested that "Every representation of movement awakens in some degree the actual movement which is its object" (p. 526). He believed that spontaneous mimicry was a result of automatic activation of previously learned stimulus–response relationships, similar to associative priming in which the presence of the stimulus increases the probability of a response. Another view suggests that the tendency toward mimicry can be accounted for by contagion, similar to contagious yawns or laughter, in which others first induce a similar emotional response, which then induces a similar action (Hatfield, Cacioppo, & Rapson, 1994; Laird et al., 1994). Neither of these accounts necessarily suggests that embodied processes play an active, constitutive role in perception.

The embodied perspective, however, suggests that the mimicry response can be the behavioral manifestation of the embodied perceptual process that contributes meaningful information toward the understanding of the visual stimulus. Thus, people smile when they observe a smile in someone else because the activation of one's own facial muscles helps them perceive the happiness of the other person. Similarly, people make slight movements of their arms while watching a sword fight because it is through the activation of the arm muscles that the observer is able to understand the action. Though these behaviors could be a result of the reflexive response that James speaks of, we humans are also able to mimic novel and nonevolutionarily relevant actions. Thus, a stimulus–response loop cannot fully account for the total range of mimicry responses.

A study conducted by Reed and Farah (1995) speaks to the causal contribution of embodiment in perception of action. Participants were asked to either move the same limb (arm or leg) as the observed action or the opposite limb. Results suggest that recognition of others' actions was significantly improved when the observer moved the same limb. In other words, if the observer was moving his own arm, he was more likely to recognize that the confederate moved her arm than her leg. This finding held up even when selective attention and conscious mimicry were controlled. Reed and Farah concluded that the participants used their own body schema to process the others' movements.

Embodied processes might also play a role in the perception of objects that are capable of being manipulated. Behavioral studies find that if subjects are asked to state whether a cup is upside-down or right-side-up, their response is facilitated if the cup's handle is on the same side as the response hand (Tucker & Ellis, 1998). This facilitation could be mediated by "canonical neurons" (located in the same brain regions that contain mirror neurons), which respond to graspable objects.

Perception of others' actions, as expressed in movements, and producing the appropriate behavioral response is critical to social interaction. However, of even greater importance for social perception is understanding the thoughts, intentions, and emotions that produced the observed behavior. The following studies demonstrate that embodied cognition serves the purpose for understanding not only the surface perception, but also the underlying mental states that motivated the perceived behavior (for a review, see Niedenthal et al., 2005).

Let us start with the simple case of mental state attribution – emotion recognition. One early behavioral study that supports the role of embodied processes in social perception was conducted by Wallbott (1991). In this study, participants were videotaped while they performed an emotional facial recognition task. Each participant was then brought back to the laboratory for a subsequent session and asked to guess, on the basis of the videotape of his or her own face, what facial expression was presented on the previous session. The participants' judgments of their own facial expressions matched those of the presented stimulus at above chance levels, suggesting that the participants were imitating the facial expressions of the people they were judging. Additionally, the recognition rate from the original study correlated with individuals' recognition rate of their own (videotaped) facial expressions.

Niedenthal, Brauer, Halberstadt, and Innes-Ker (2001) examined the possibility that mimicry is causally involved in the perception of the facial expression of emotion. Participants were asked to identify the point at which a morphed face changed from happy to sad and vice versa. During this task, some participants were free to move their faces naturally, whereas others were holding a pen sideways in their mouths, between their teeth and lips This manipulation prevents facial mimicry and thus reduces somatic feedback that supports the detection of change in the observed expressions. Participants whose facial movements were blocked by the pen detected the change in expression later in both directions (happy to sad and sad to happy) than those who were able to move their face freely, supporting the role of facial mimicry in the recognition of facial expressions.

Oberman, Winkielman, and Ramachandran (2007) extended this study by adding several controls and, more importantly, examining the specificity of the mimicry-blocking effect. Note that the embodiment account predicts that recognition of a specific type of facial expression should be impaired by blocking mimicry in the group of facial muscles used in the production of this type of expression. The authors tested this hypothesis using four expressions (happy, disgust, fear, and sad) and four manipulations of facial mimicry: holding a pen sideways between the teeth, chewing gum, holding the pen just with the lips, and no task. The study found that the pen-in-the-teeth manipulation (which selectively activates the muscles involved in producing expressions of happiness) selectively impaired the recognition of happiness, but had no effect on the recognition accuracy for disgust, fear, and sad expressions. This finding suggests that recognition of a specific type of facial expression involves the selective recruitment of muscles used to produce that expression, as predicted by embodiment accounts.

## NECESSITY OF EMBODIED PROCESSES FOR SOCIAL PERCEPTION

The previous sections of this chapter provided evidence for the existence and possible benefit of embodied processes in typical social perception. In this section we will propose that without embodied processes, social perception can be rather severely impaired. This conclusion is suggested by studies of clinical populations in which deficits in embodied processes are associated with deficits in social perception.

A study conducted by Ramachandran and Rogers-Ramachandran (1996) found that patients with anosognosia (denial of illness) that was due to damage to the right parietal and frontal cortices denied not only their own paralysis, but also the paralysis of another individual. The authors conclude that damage to an individual's own body schema may lead to deficits in making judgments about another individual's actions, again suggesting that having an embodied model to compare a perception to is necessary for accurate social perception.

Adolphs, Damasio, Tranel, Cooper, and Damasio (2000) provided evidence for the necessity of embodied processes in perception with another patient group. One hundred and eight focal brain lesion patients and 30 healthy control participants participated in three visual emotion recognition tasks. In the first task, participants were asked to rate the intensity of basic emotional facial expressions. In the second task, participants were asked to match a facial expression with the name of the emotion it is meant to convey. The final task required participants to sort facial expressions into emotional categories. Though each task identified a slightly different group of regions, damage to primary and secondary sensorimotor cortices impaired performance in all three tasks, supporting the critical role of sensory and motor cortices in the perception of emotion conveyed in visually presented faces.

The dependence of facial expression recognition on somatosensory cortices was also illustrated in a recent study by Pitcher Garrido, Walsh, and Duchaine (2008). In this study, healthy participants were given TMS that is capable of creating a "virtual" reversible lesion (or suppression of activity) in specific brain regions. Specifically, researchers targeted both the right occipital face area (rOFA) and right somatosensory cortex while participants discriminated facial expressions. TMS to either region, in the crucial time between 100 and 200 ms after presentation of expression, impaired discrimination of facial expressions but had no effect on a facial identity task.

These findings are contrasted with a study conducted by Calder, Keane, Cole, Campbell, and Young (2000) in which three patients with Mobius syndrome (a congenital condition that causes facial paralysis) were able to appropriately categorize faces from the Ekman and Friesen (1976) Face Stimulus set. Thus, it is important to note that though embodied processes likely are involved in emotion recognition, this ability can also be subserved through disembodied mechanisms, and an impairment in recognition may be recognizable only with very specific task conditions.

## DISORDERS OF EMBODIMENT

Certain populations provide organic insight into the role of embodiment in perception. These include disorders on the autism spectrum and schizophrenia as well as rarer conditions such as Capgras syndrome, phantom limb pain, somatoparaphrenia, apotemnophilia, and hypermimicry (echopraxia) in patients with frontal lobe lesions.

## *Autism Spectrum Disorders*

Autism is characterized by severe deficits in comprehending the behaviors of other people (social perception). Recent studies suggest that impairments in embodied processing may contribute to the deficit in social perception (for review, see Winkielman, McIntosh, & Oberman, 2009).

In one study, McIntosh, Reichmann-Decker, Winkielman, and Wilbarger (2006) showed pictures of happy and angry facial expressions to adults with autism spectrum disorders (ASD) and matched controls. In one condition, participants were simply asked to "watch the pictures as they appear on the screen." In another condition, participants were asked to "make an expression just like this one." Mimicry was measured by electromyography (EMG), with electrodes placed over the cheek (smiling) and brow (frowning) regions. In the voluntary condition there were no group differences, with ASD participants showing a normal pattern of voluntary mimicry (smile to a smile, frown to a frown). However, in the spontaneous condition only typical participants mimicked, with ASD participants showing no differential responses.

Interestingly, a recent study showed that under some conditions ASD participants will show spontaneous facial mimicry when, for example, they are focused on the task of recognizing emotions from the screen (Oberman, Winkielman, & Ramachandran, 2009). However, even then the mimicry is temporarily delayed, by about 200 ms, which could be critical for the ability of the somatic feedback to facilitate face recognition processes (Pitcher et al., 2008).

Indeed, this absence or delay of spontaneous mimicry may explain why participants with ASD have difficulties recognizing facial expressions under brief presentation conditions. Clark, Winkielman, and McIntosh (2008) compared ASD and control individuals on extraction of emotional and non-emotional information from stimuli presented briefly, in the range of micro expressions (15 and 30 ms), or for a long time (3 s). Participants' task was to detect if (i) emotional faces were happy or angry, (ii) neutral faces were male or female, and (iii) neutral images were animals or objects. ASD individuals performed selectively worse on emotion extraction from faces (60% versus about 75% for control groups). There were no group differences on gender or animal–object tasks, with groups all performing around 65%–70%. Importantly, there were no group differences in accuracy, which was perfect (100%) on any type of stimulus when pictures were presented at long stimulus duration (3 s). These findings suggest that participants with ASD can perform emotion detection under favorable presentation conditions, where presumably they use "disembodied" strategies, but have difficulties under brief condition where presumably they utilize their own facial feedback. Future studies should directly test the role of various embodiment mechanisms in perception of facial emotions among ASD individuals.

It has also been proposed that the social deficits in individuals with ASD result from impairments in the MNS (Oberman & Ramachandran, 2007) and their inability to spontaneously map the mental representation of the self to the representation of the other (Williams, Whiten, & Singh, 2004). Evidence consistent with these proposals has been obtained by several research groups using different techniques. First, there are reports of anatomical differences in the MNS. For example, Hadjikhani, Joseph, Snyder, and Tager-Flusberg (2006) found that ASD individuals have local decreases of brain matter in the MNS areas, which correlated with severity of ASD symptoms. Similarly, Villalobos, Mitsuro, Dahl, Kemmotsu, and Muller (2005) found that individuals with ASD have reduced functional connectivity between the primary visual cortex and the premotor mirror neuron area. Second, several studies observed functional differences in the activity of the MNS during social perception.

Electroencephalogram (EEG) studies asked typical and ASD individuals to view videos of a person executing simple actions, or to perform the same actions. Similar to the findings of Gastaut and Bert (1954), the typically developing individuals showed suppression in the oscillations over sensorimotor cortex during both the execution and observation of action. However, individuals with ASD only showed suppression when performing their own actual movement but not when observing movement, indicating reduced mirror neuron activity (Altschuler et al., 2000; Oberman, Hubbard, McCleery, Ramachandran, & Pineda, 2005).

Interestingly, there is evidence that autistic impairment in spontaneous mirroring might relate to a deficit in mapping the representation of the observed action to the self. Theoret et al. (2005) asked typical and ASD groups to view videos of index finger and thumb movements that were directed either toward or away from the participants. During these tasks, the experimenters recorded muscle activity in the index finger induced by TMS. In the typical group, both participant-directed and other-directed actions increased muscle activity, suggesting spontaneous mirroring. However, the ASD group showed spontaneous mirroring when viewing actions directed toward the participant, but not when viewing actions directed away from the participant.

An fMRI study investigated the role of mirror neurons in the perception of emotion stimuli in individuals with ASD and controls (Dapretto et al., 2005). Participants were asked to both imitate and observe emotional facial expressions. As compared to controls, ASD participants showed lower activation in a wide variety of regions, including visual cortices, primary motor, limbic, cerebellum, and Broca's area. Though the group differences in brain activations were fairly broad, one intriguing finding is a negative correlation of the activity in Broca's area with the severity of autism symptoms, measured by the Autism Diagnostic Observation Schedule (ADOS) and the Autism Diagnostic Interview (ADI). Again, these findings suggest that deficits in social and emotional understanding in autism could be due to a reduction in brain regions involved in embodied cognition.

### *Other Disorders of Embodiment*

There are several other disorders that researchers have linked to embodiment. As embodiment involves a complex series of neural computations, it can be disordered in several ways. This section will explore several different psychological and neurological conditions in which disordered embodiment manifests itself.

If the role of embodiment is to simulate what is perceived "as if" the observer is actually performing the action, then an obvious question arises as to how the observer knows if it is really him actually performing the action, or if he is simply simulating it. This distinction is critical to embodied cognition and requires additional brain systems that are activated only during execution or only during perception. The ability to know that it is you (and not simply an embodied simulation of another person) performing an action is commonly referred to as agency, and its absence is one of the primary features of schizophrenia. Schizophrenia is characterized by auditory verbal hallucinations and delusions that other people are influencing their actions and thoughts (American Psychiatric Association, 1994). Patients with schizophrenia also often have difficulty in recognizing other people's actions and with expressing emotions through facial expressions and verbal communications. They also have difficulty in recognizing emotions on other people's faces (Penn & Combs, 2000).

The role of embodied cognition in schizophrenia has not been as well studied as it has in ASD. However, recently, Buccino and Amore (2008) argued that some behavioral symptoms of schizophrenia can be attributed to a dysfunction in embodied perception. This claim is supported by two behavioral studies where patients with schizophrenia were asked to perform simple hand movements without visual control. During the experiment the patients had to judge whether a hand presented on a screen was theirs or someone else's. These patients were not able to discriminate their own hand and sometimes attributed an alien hand to themselves (Daprati et al., 1997; Franck et al., 2001). These studies elegantly support the proposals that the lack of agency in patients with schizophrenia may lead to unconstrained embodiment. More generally, these results suggest that to assure successful processing, embodied systems of perception must be paired with other systems that provide a sense of agency to dissociate embodied perception from true experience.

Two rare conditions, somatoparaphrenia and apotemnophilia, also speak to the importance of agency in perception. In somatoparaphrenia the patient vehemently denies ownership of his left arm or leg, often attributing it to the examining physician or a spouse or sibling who may not even be in the vicinity. In these cases the patient sometimes develops an actual aversion to the limb. Likewise in apotemnophilia, otherwise sane and rational individuals express a strong and specific desire for the amputation of a healthy limb or limbs and suggest that it is not part of them. These disorders suggest that embodiment is relevant not only for the perception of others, but also the perception of one's own body.

It has previously been suggested by Brang, McGeoch, and Ramachandran (2008) that apotemnophilia results in representation of a specific body part (e.g., arm) being congenitally absent from their body image representation. However, the sensory input from the arm to primary and secondary somatosensory cortices is intact (because the limb itself is intact). It was suggested that this discrepancy between somatosensory cortices and body image representations in the parietal lobe leads to the characteristic alienation and aversion to the limb expressed by individuals with apotemnophilia. Mere loss of sensory input to primary somatosensory cortex (e.g., brachial plexus avulsion, leading to complete denervation of an arm) does not lead to the aversion or desire for amputation because the signal does not reach secondary somatosensory cortex and fails to be relayed to the body representation so there is no discrepancy. Brang and colleagues (2008) tested this conjecture and found abnormal skin conductance response (SCR – a measure of autonomic arousal) when the affected limb was touched, but not when the other (unaffected) arm was touched. Since SCR is an automatic response, this finding provides compelling evidence for the disconnection between somatosensory cortices and body image representation.

In somatoparaphrenia the lesion affects both primary and secondary somatosensory cortices as well as body image representations in the parietal lobe. Consequently there is disownership, but no actual aversion since there is no discrepancy. However, if there is only partial rather than complete damage to either secondary somatosensory cortex or the parietal cortex, this creates some level of discrepancy, and sometimes aversion to the body part can be observed.

Interestingly, the abovementioned syndromes suggest that one's body image is intimately linked to emotions. Another condition in which a failure in embodied perception leads to delusions and sometimes aversion is Capgras syndrome. Capgras syndrome is characterized by the belief that an acquaintance, usually a spouse or other close family member, has been replaced by an identical looking impostor. Hirstein and Ramachandran (1997) argue that this delusion is a result of a disconnection between visual areas (especially fusiform gyrus) and the limbic (emotional) system. This leads to the inability to evoke relevant emotions on seeing a familiar individual. When these feelings are not evoked, the response is not simply recognition without emotions, but rather a delusion that it is a different person. This argument further suggests that the perception of a familiar person goes beyond their visual appearance to include also the embodied experience (including evoked emotions) of seeing that person. Two groups (Ellis, Young, Quayle, & De Pauw 1997; Hirstein & Ramachandran, 1997) tested the role of embodiment in perception of familiar individuals by using SCR. They found a reduced autonomic response to the person about whom the patient was delusional (usually the patient's mother), despite intact general ability to produce SCR responses. Thus, in addition to the two standard visual pathways (dorsal stream for action and ventral stream for object and face recognition), there appears to be a third pathway that lies ensconced between them and projects via a cortical area just below the inferior parietal cortex to the limbic structures. Capgras syndrome may be a result of damage to this "emotional–visual" pathway that, not coincidentally perhaps, overlaps with mirror neuron regions. These speculations await further testing.

In all of the above examples, the patients had access to their own physiological body feedback, but that feedback was somehow misinterpreted. But what happens if you lose that sensory feedback completely? Do you lose your ability to use embodied processes? The answer to this question comes in a recent study conducted by Ramachandran and Rogers-Ramachandran (2008). In this study, researchers asked two patients who experienced phantom sensations in their amputated arm to watch someone else being touched. The results were astonishing. Although a typical individual might activate his or her sensory representation in response to the perception of someone being touched, he or she wouldn't literally experience the other's touch. This is presumably because the lack of sensory input from the observer's intact limb overrides the embodied mechanisms. If the sensory input, however, is removed by amputating the limb, the override is also removed. As a result of the loss of the limb, phantom limb patients literally experience their own phantom hand being touched. In one of the patients, merely watching another subject's intact arm being massaged reduced the pain in the phantom. Ramachandran and Rogers-Ramachandran (2008) attribute this finding to a lack of sensory feedback leading to a corresponding lack of inhibition of complete embodiment of the perception. Further studies are necessary to confirm this finding.

The abovementioned examples all illustrate how embodied cognition allows us to peek into the elusive interface between body and mind and self and other. Disturbances in this interface can lead to a dissolution of self/other barriers, resulting in various psychological conditions. Additionally, there does appear to be one neurological condition that leads to hyperembodiment, which can be as disabling as no embodiment at all. In a study conducted by Lhermitte, Pillon, and Serdaru (1986) the researchers observed imitation behaviors in patients with lesions to the frontal lobe. Imitation behavior was defined as the persistence of imitation of the gestures and behavior of the examiner when the patient has not been asked to do so, and the continued imitation after being asked to stop. For these patients, the authors write "The sight of a movement is perceived in the patient's mind as an order to imitate; the sight of an object implies the order to use it." Of the patients with this behavior, 96% (28/29) had damage to the frontal lobe and of those 28 patients, 26 (93%) had damage to the inferior half of the anterior part of one or both frontal cortices. Thus, for embodied perception to work effectively, we not only need to be able to access our own body representations and interpret them appropriately, leading to mimicry. We also need to have some inhibitory mechanisms present to stop us from fully representing the perception of someone else in our own motor system, leading to mimicry that is uncontrolled.

## CONCLUSIONS AND FUTURE DIRECTIONS

In this chapter, we have argued that theories of embodied cognition offer a fruitful theoretical approach to investigating visual perception. We began by suggesting that the brain regions traditionally thought of as visual cortex in the occipital, inferior temporal, and posterior parietal lobes are not sufficient for visual perception. Though clearly they play a critical role in "seeing," "perceiving" is a much more complex process that involves the entire brain and arguably the extended nervous system. We then provided behavioral, electrophysiological, and neuroimaging evidence for the existence and benefit of embodied processes in visual perception. Finally, in the last section, we summarized several studies that speak to the necessity of embodied processes for social perception. Specifically, we suggested that dysfunction of embodied processes due to lesions or mental disorders can lead to specific impairments in social perception.

Of course, there are open questions that still need to be explored. For one, how does one develop embodied processes? Are they hardwired and present from birth or are they acquired through learning, or a combination of both? The presence of behavioral spontaneous mimicry at birth as demonstrated by Meltzoff and Moore (1977) has been interpreted as evidence that some embodied processes do not have to be learned. However, there have been criticisms of these studies suggesting that the specific movements were a result of an innate releasing mechanism to feed, as the movements were limited to mouth opening, tongue protrusion, and hand opening, and the researchers suggest that the pattern of imitation is not likely the result of conditioning or innate releasing mechanisms. They argue that this early imitation implies that human neonates have an innate ability to equate their own unseen behaviors with gestures they see others perform.

However, it is possible that the actions investigated by Meltzoff and Moore (1977) were not, as suggested, based on an innate shared circuit, but rather could have been a reflex in response to a smile – like a sneeze in response to pepper. One way to find out would be to test whether infants can mimic an asymmetrical smile or another uncommon action. This would eliminate the “reflex” explanation and implicate a more sophisticated hardwired mechanism based on preexisting rules of translating visual appearance of the body into motor output, leading to accurate imitation.

If one assumes that most embodied processes are not innate, but rather learned, this opens up a bigger question. Namely, how are they learned? Is it an active process, or just a result of Hebbian association? For example, if every time a child reaches for something a motor command neuron fires and the child also sees his hand reaching, thus activating visual neurons, the two neurons (motor and visual) may become linked through Hebbian association. Over time, the motor neuron itself can be activated by the visual image of a reaching movement, even if the visual image is of another person’s hand.

To answer these questions, one could record from the mirror neuron regions in a newborn macaque and expose the monkey to several actions, including actions that he will likely be exposed to early in life (e.g., peanut breaking, grasping), as well as novel actions that are unlikely to be based on preexisting hardwired mechanisms. If mirror neurons respond to both the familiar and novel actions the first time they are presented, that would argue for an innate system that does not depend on Hebbian association mechanisms. If mirror neurons respond only to the familiar actions, then the same argument could be made for these findings as was made for the findings by Meltzoff and Moore, that the brain is hardwired to respond to certain evolutionarily relevant actions. Finally, if no mirror neurons respond to the observation of any actions in newborn monkeys, this would argue against mirroring being innate. There are currently several possible mechanisms for the development of embodied processes. It is our prediction that, like other systems in the brain, these types of “shared circuits” are neither purely learned nor purely innate, but a result of both hardwired and learned processes.

Though challenges remain, it is clear that the embodiment approach offers, has inspired, and is continuing to generate research that advances the understanding of how we perceive our world. We hope this review captures some of this excitement and points to some useful directions for future research.

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# Section III

# Ecological Approach to the Social Psychology of Visual Perception

# 10

# Top-down Influences on the Perception of Ongoing Behavior

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> Is the stream of behavior seen as a continuum or as a sequence of discrete units? If the latter, do different people see the same units? People behave toward others, and they speak and write about their own and others' behavior as if they perceive behavior in units; and the degree of harmony with which interacting individuals guide their behavior suggests considerable agreement regarding the beginning and end-points of the behavior units they discern. (Harold R. Dickman, 1963, p. 23)

The perception of human action is core to social psychology, yet over the years it has not received nearly the scientific study lavished on post-perception, cognitive operations (e.g., the selective retrieval of information from memory). It is not surprising, then, that prevailing accounts of a variety of social psychological phenomena (e.g., the effect of prior expectations on evaluations) inevitably emphasize cognitive or inferential mechanisms over perceptual mechanisms. Is it the case that perceptual accounts of many social psychological phenomena are not feasible, or is it the case, perhaps, that the cognitive framework has so dominated the field that few investigators have even sought to seriously explore the question of their tenability? The research highlighted in this chapter will show beyond all doubt that the former conclusion at least is decidedly incorrect. In keeping with the overall theme of this volume, the work to be described focuses on various top-down factors that alter how people initially perceive the actions of others (and in some instances, on the downstream consequences directly associated with these alteration in perception). Most of the studies discussed herein employed the behavior unitization paradigm first introduced by Newtson (1973). As such, it is necessary to begin with an overview of the unitization paradigm and an examination of some of the seminal findings it produced.

## THE PERCEPTION/UNITIZATION OF ONGOING BEHAVIOR

Consistent with the epigraph that begins this chapter, Newtson (1973, 1976a, 1980; Newtson, Hairfield, Bloomingdale, & Cutino, 1987) argued that perceivers register information from ongoing behavior episodes by subjectively parsing them into units of meaningful action. To measure this unitization process in the laboratory, participants are presented with a filmed or videotaped sequence of behavior and are instructed to simply press a button (activating a recording device) whenever they notice one meaningful action end and a different one begin. Participants are typically given a few examples of how a sequence could be "unitized" in this manner, but it is always emphasized that there are no right or wrong ways to perform the task.

The points in an observed sequence that elicit a button press from participants indicate the boundaries of a perceived action. These boundaries have been dubbed "breakpoints" because they mark the locations at which the continuous stream of behavior is "broken" into its component actions. Locations in the stream of behavior that do not elicit a button press from participants are correspondingly called "nonbreakpoints." According to Newtson (1976b, p. 119), an observer of another's behavior "monitors some critical set of features (a subset of the available features), segmenting the behavior into parts as one or more of the monitored features change state." A breakpoint, then, is a location in the behavior sequence "where a noticeable change in state of one or more of the observer's criterial features has occurred" (Newtson, 1976a, p. 236). From this perspective, action perception is said to comprise the subjective identification of successive "points of definition" (breakpoints) in the behavior stream (Newtson, Engquist, & Bois, 1977; Newtson, Rindner, Miller, & LaCross, 1978).

Newtson's theory of behavior perception is congruent with the views of several prominent psychologists, including Asch (1952), Heider (1958), Gibson (1966), and Neisser (1976). For example, Neisser (1976) asserted that environmental stimuli and internal aspects of the individual are both critical determinants of what is perceived. Moreover, he argued that even though not all properties and meanings of an attended stimulus are apprehended or registered by perceivers, "every natural object has a vast number of uses and potential meanings, and every optic array specifies an indefinite variety of possible properties" (Neisser, 1976, p. 72). Similarly, Asch (1952, p. 58) noted that "the examination of phenomenal experiences alone cannot be the sole method of psychological investigation. To do so would be to divorce the facts of consciousness from their sources in *objective conditions and in organic processes*" (emphasis added). Notwithstanding its compatibility with the conceptual frameworks of a number of important theorists, the viability of Newtson's proposed model of the behavior perception process ultimately depends on whether it is capable of garnering compelling empirical support.

### *Evidence of Behavior Units and Their Perceptual Nature*

Newtson and Engquist (1976) conducted a set of experiments both to establish the reality of behavior units and to confirm their perceptual basis. In an initial experiment, Newtson and Engquist hypothesized that if breakpoints are indeed more critical stimulus points in the stream of behavior than nonbreakpoints, then interruptions occurring at the former should be more readily detected than interruptions occurring at the latter. Consistent with their prediction, Newtson and Engquist demonstrated that deleted frames in several short film sequences were harder for observers to detect if they were located at nonbreakpoints than located at breakpoints, regardless of whether the number of deleted frames was 4, 8, or 12. It is important to note that breakpoints and nonbreakpoints were identified with the unitization technique by a pretest group of participants; the actual observers who reported the occurrence of deletions did not perform the unitization task. Therefore breakpoints, where action-unit formation occurs, indeed appear to possess distinctive properties that nonbreakpoints do not. (In a fascinating study by Baldwin, Baird, Saylor, and Clark [2001] that dovetails with the above results, infants were shown one of two brief movies of a woman working in a kitchen. Each movie depicted a goal-directed action sequence [retrieving a fallen dishtowel or placing a container of ice cream in a freezer]. Later, infants were presented with excerpts from the films with 1-s pauses inserted into them. The pauses were located either at the moment when the woman completed a salient action [e.g., picking up the towel] or shortly before that point. The infants looked longer at the excerpts when the pauses were placed before the action completions, suggesting that they found those more disruptive.)

A second study by Newtson and Engquist (1976) further established that breakpoints represent the location in a behavior sequence of significant information available for pick-up by perceivers. Breakpoints and nonbreakpoints identified by pretest participants were extracted from event sequences and mounted as slides. New participants then viewed triads of successive breakpoints and nonbreakpoints that were in either correct or incorrect order. These observers were asked to provide for each set of three slides (taken as a whole) a rating of its intelligibility, a description of the action depicted, and a judgment as to whether the slides were presented in the correct order.

Results revealed that breakpoints were rated as more intelligible than nonbreakpoints, with presentation order affecting only ratings of breakpoints. Intelligibility of slide triads in the breakpoint–correct order condition was comparable to that of the complete continuous sequences from which they were extracted (the latter ratings provided by pretest participants). Action descriptions were evaluated for accuracy by two independent raters according to protocols developed from descriptions provided by pretest participants who viewed the entire sequences. Inter-rater agreement was high, so the two sets of ratings were summed into a single accuracy index. Analysis of this index revealed that triads of breakpoints were more accurately described by participants than were triads of nonbreakpoints. Finally, order judgments of triad slides were far more accurate when they consisted of breakpoints (80% correct) than nonbreakpoints (42% correct). In instances where order was accurately judged to be incorrect, participants were considerably more successful at correctly reordering breakpoints than nonbreakpoints (46% vs. 13% accuracy).

In a third and final experiment, Newtson and Engquist (1976) provided additional converging evidence of the distinctiveness of breakpoints by examining observers' recognition memory for breakpoints and nonbreakpoints. A pretest group was used to identify breakpoints and nonbreakpoints in several behavior sequences and these were mounted as slides. New participants, some instructed to unitize and others not, viewed half of the continuous sequences from which these slides were drawn. Subsequently, these participants were presented with a number of slides of breakpoints and nonbreakpoints; some of these were "old" in that they were from sequences that had been viewed, and some were "new" in that they were from sequences that had not been viewed. Participants' task was to indicate for each slide whether it was "old."

Consistent with Newtson and Engquist's (1976) expectation, results revealed that correct recognition of breakpoints was superior to that of nonbreakpoints. Importantly, this was true whether participants had explicitly unitized the sequence or not, thus ensuring that the observed recognition differences were not an artifact of participants having simply engaged in the button-pressing task, and suggesting that the process of unitization goes on implicitly in the absence of experimenter instructions. Finally, a signal detection analysis indicated that the greater recognition of breakpoints was not the result of a positive response bias, but instead reflected real differences in discriminability.

Perhaps the most compelling support for Newtson's conceptualization of the perception of human action comes from an experiment that employed noninvasive neuroimaging techniques to explore how the brain accomplishes the spontaneous unitization of observed events. Using functional magnetic resonance imaging (fMRI) technology, a team of researchers (Zacks et al., 2001) identified a network of brain regions that responds selectively to breakpoints, regardless of whether observers are performing the unitization task or simply watching an event as they naturally would. Moreover, Zacks and his colleagues determined that the sites of the most transient brain activity in response to breakpoints were located in visual-processing areas known to process movement information. This finding further supports the conclusion that the process of rendering continuous event sequences into discrete action units is predominately perceptual rather than conceptual in nature, and is also consistent with Newtson and colleagues' contention that people use (although not exclusively) movement (change) cues to identify these units. Finally, in concordance with Newtson and the other theorists mentioned previously, Zacks and his colleagues note that behavior unitization depends not only on the bottom-up processing of sensory features such as movement but also on top-down input that frequently establishes how much and what kind of information is required by perceivers of another's behavior (cf. Zacks & Swallow, 2007).

### *Variation in Behavior Perception as a Means of Regulating the Quantity and Quality of Information Gain from the Observation of Ongoing Events*

According to Newtson's (1973, 1976b) model of behavior perception, perceivers can maximize the amount of potential information they extract from ongoing behavior by parsing it into smaller units of action – that is, by employing a finer level, or higher rate, of unitization. In support of this proposition, Newtson (1973, Experiment 1) found that individuals instructed to segment an actor's behavior into fine units (i.e., into the smallest component actions) later ascribed traits to the actor with greater confidence than did individuals instructed to segment his behavior into gross units (i.e., into the largest component actions). Further evidence that a fine level of unitization provides perceivers with more potential information about an observed other is demonstrated by studies showing that increases in unitization rate are associated with enhanced memory for the specific actions of another (Geers & Lassiter, 1999; Hanson & Hirst, 1989; Lassiter, 1988; Lassiter & Slaw, 1991; Lassiter, Stone, & Rogers, 1988).

In addition, several factors that influence the level of behavior unitization employed in a given situation have been identified and these too suggest that the unitization process functions to regulate the quantity of information gained during the observation of behavior. One such factor is the inherent predictability of a behavior sequence. Multiple studies have demonstrated that unpredictable behavior (e.g., actions that do not fit readily with the immediately preceding pattern of behavior) is generally unitized more finely than predictable behavior (Newtson, 1973, Experiment 2; Wilder, 1978a, 1978b). Similarly, it has been shown that perceivers who lack any prior knowledge about what is actually going to transpire in an observed behavior sequence tend to employ a higher rate of unitization than do perceivers who naturally possess or are provided with such knowledge (Engquist, Newtson, & LaCross, 1979; Graziano, Moore, & Collins, 1988; Markus, Smith, & Moreland, 1985). It has also been found that perceivers adopt a finer level of unitization when the information contained in a behavior sequence is high in personal interest or is of considerable subjective importance (Hogue & Atkinson, 1989; Russell, 1979). Finally, investigations examining individual differences in behavior unitization (Lassiter, Briggs, & Bowman, 1991; Lassiter, Koenig, & Apple, 1996) have reported that people high in need for cognition (Cacioppo, Petty, Feinstein, & Jarvis, 1996) – who are characterized by their propensity to seek out and carefully consider information – typically discriminate more meaningful actions in an observed other's behavior than do people low in need for cognition (see also Viswanathan, 1997 for a similar result using his Need for Precision Scale). Taken together, these findings indicate that factors that produce or are associated with a heightened desire or need for information generally cause perceivers to unitize behavior in a more fine-grained, detail-oriented manner.

The above research amply demonstrates that perceivers control the amount of information they pick up during behavior observation by differentiating many or a few distinct action units. It is important to note that perceivers also determine the *kind* of information they register by varying their unitization pattern – that is, by identifying different actions as meaningful. When perceivers diverge in their observational goals (Cohen & Ebbesen, 1979), in their prior interpretive sets (Engquist et al., 1979; Geers & Lassiter, 2002; Massad, Hubbard, & Newtson, 1979), or in their observational skill levels (Newtson, Rindner, & Campbell, 1979), it has been shown that there can be concomitant shifts in their patterns of unitization. For example, Cohen and Ebbesen (1979) found that individuals whose observational goal was to learn an actor's task behavior registered a different set of action units than did individuals whose goal was to form an impression of the actor. This result seems quite reasonable in that the specific actions that help one learn a task versus form an impression are not likely to be same.

Studies that have included unitization-rate data as well as unitization-pattern data indicate that perceivers sometimes vary only their unitization rate (e.g., Lassiter, 1988; Lassiter et al., 1996; Newtson, 1973), sometimes vary only their unitization pattern (e.g., Geers & Lassiter, 2002; Massad et al., 1979; Newtson et al., 1979), and sometimes vary both (e.g., Cohen & Ebbesen, 1979; Engquist et al., 1979). (See Figures 10.1–10.3 for graphic depictions of these three possibilities.) When perceivers who unitize grossly generate a unitization pattern that is comparable to perceivers who unitize finely, it suggests that the same basic information is being obtained by both sets of perceivers, with only the amount of detail varying. When unitization rates are similar, but patterns of unitization diverge, it suggests that perceivers are extracting the same amount of information overall, with only the nature of the information varying. Finally, when both rate and pattern of unitization differ, it suggests quantitative as well as qualitative variation in information pick-up.

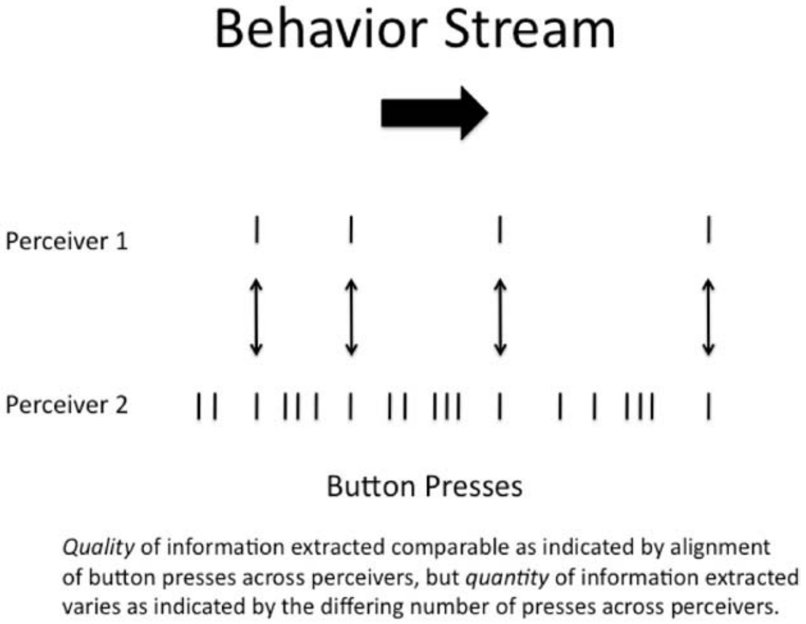
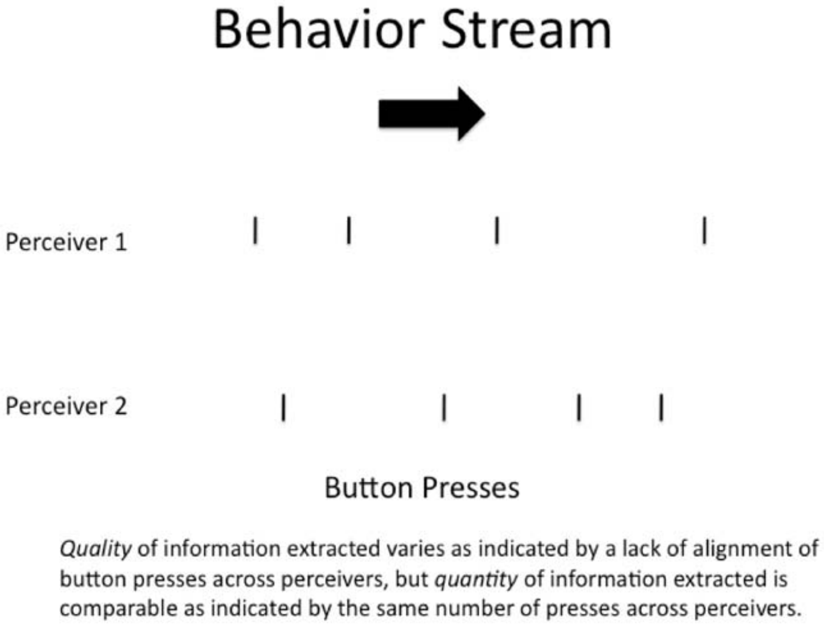
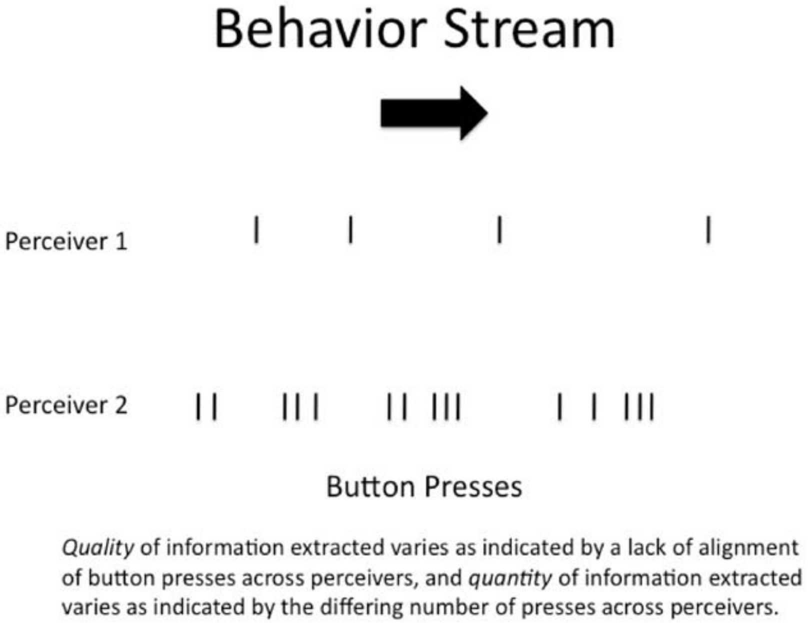


FIGURE 10.1 Example of two perceivers with comparable unitization patterns but different unitization rates for an observed behavior stream.



*Quality* of information extracted varies as indicated by a lack of alignment of button presses across perceivers, but *quantity* of information extracted is comparable as indicated by the same number of presses across perceivers.

FIGURE 10.2 Example of two perceivers with different unitization patterns but comparable unitization rates for an observed behavior stream.



*Quality* of information extracted varies as indicated by a lack of alignment of button presses across perceivers, and *quantity* of information extracted varies as indicated by the differing number of presses across perceivers.

FIGURE 10.3 Example of two perceivers with different unitization patterns and different unitization rates for an observed behavior stream.

## TOP-DOWN INFLUENCES ON THE PERCEPTION/UNITIZATION OF ONGOING BEHAVIOR: RECENT FINDINGS

The remainder of the chapter will focus on three sets of studies conducted by Lassiter and his colleagues that demonstrate how and why top-down factors – that is, observational goals, prior expectations, and prejudicial attitudes – can cause actual alterations in people's perception of, and consequent reaction to, observed behavior sequences. These particular factors were chosen in part because they have been traditionally argued to exert considerable influence on higher-order cognitive operations, yet have not been extensively investigated in terms of their impact on perceptual processing.

### *Observational Goals*

As noted above, Cohen and Ebbesen (1979) reported evidence that perceivers unitized behavior sequences differently depending on whether their assigned goal was to learn/memorize what an actor was doing or to form an impression of him or her. Lassiter, Geers, Apple, and Beers (2000) pointed out some limitations of Cohen and Ebbesen's (1979) study and conducted two experiments that clarify several aspects of the effect of observational goal (i.e., learn/memorize task vs. form impression) on behavior unitization.

First, Lassiter et al. (2000) established more definitively that perceivers with different observational goals do indeed unitize ongoing behavior differently in terms of the *quality* of information they extract. Cohen and Ebbesen's (1979) data suggesting unitization pattern differences was equivocal because their use of a within-subjects design and analysis made demand characteristics a plausible explanation for such a result. That is, participants unitized behavior sequences first under one set of instructions and then a second time under the other set of instructions. In such circumstances, participants may have felt they should change their unitization responses on the second viewing irrespective of what instructions they received. Lassiter et al.'s (2000) use of a between-subjects design ruled out the possibility of this particular artifact. Second, Lassiter et al.'s (2000) addition of a control condition, in which perceivers received no special instructions regarding observational goals, demonstrates conclusively that having a specific goal such as learning a task or forming an impression causes perceivers to be more selective in the information they extract, leading them to take in less information overall. Third, Lassiter et al. (2000) showed that when viewing event sequences of prototypical, highly structured tasks, participants whose aim is to learn the task do not necessarily pick up any more information than those whose aim is to form an impression of the actor. This contrasts with Cohen and Ebbesen's (1979) conclusion (based on their use of unstructured, esoteric task sequences) that instructions to learn a task invariably lead to finer unitization than instructions to form an impression.

As a whole, Lassiter et al.'s results fit nicely with the view espoused by Neisser (1976, p. 20) and others (Newtson, 1980; Newtson, Engquist, & Bois, 1977) that anticipatory schemata "prepare the perceiver to accept certain kinds of information rather than others and thus control the activity of looking." Participants in Lassiter et al.'s (2000) experiments who received either learn-task or form-impression instructions were provided with a specific goal for viewing the behavior. Having such a clear goal in mind appears to have led them to pick up only the information that was most relevant to that goal. Control participants, in contrast, were not given a specific observational goal, and so what they deemed relevant or important was left up to them. Lacking the single-minded focus of their form-impression and learn-task counterparts, control participants likely picked up information about the kind of person the actor was, as well as the nature of the task she was performing, thereby accounting for their greater information gain overall.

Although Cohen and Ebbesen's (1979) reported finding that the goal of learning a task leads to a finer level of unitization than does the goal of forming an impression has been frequently cited in the work of others (e.g., Hogue & Atkinson, 1989; Markus et al., 1985; Massad et al., 1979), it appears that it is not highly generalizable. Across three disparate task activities (making a quilt, baking cookies, and doing homework), Lassiter et al. (2000) found no quantitative differences in unitization for perceivers asked to learn a task or to form an impression. One explanation for Cohen and Ebbesen's (1979) original result is that their participants viewed task sequences that depicted minimal goal-directed activity (e.g., in one a seated actor leafed impatiently through a magazine; she then rose and paced back and forth, glancing anxiously at her watch), which tend to elicit higher rates of unitization (Wilder, 1978b). Lassiter et al.'s (2000) participants, in contrast, viewed more standard, hierarchically organized task sequences that, the authors contended, enabled those asked to learn the task to employ a grosser level of unitization. In a sense, then, Cohen and Ebbesen's (1979) learn-task condition was similar to Lassiter et al.'s (2000) control condition in that, in both cases, perceivers likely established a less stringent criterion for what constituted a meaningful action.

Ratcliff and Lassiter (2007) noted that it was unclear whether people must be consciously aware to initiate a change in the manner in which they unitize an observed behavior sequence. In the many unitization studies in which participants were explicitly instructed to segment behavior into either fine or gross units (for example, Lassiter, 1988; Newtson, 1973, Experiment 1), it can be assumed that they were indeed cognizant of their intention to comply with the experimental instructions. However, for those studies in which variation in behavior unitization was induced less directly – for example, by explicitly providing participants with different observational goals (such as learn task vs. form impression) – it was not known definitively whether participants were consciously choosing to alter their unitization in response to the specific goals they were provided with or not.

To answer this question, Ratcliff and Lassiter (2007) conducted the first systematic test of whether variation in behavior perception can be induced nonconsciously. To accomplish this, they used the same Scrambled Sentence Test priming technique (Srull & Wyer, 1979) employed by Chartrand and Bargh (1996, Experiment 1) to activate either an impression-formation or a memorization goal in participants. All participants then viewed and unitized a videotaped behavior sequence similar to ones used by Cohen and Ebbesen (1979) – that is, depicting minimal goal-directed activity – in their investigation of the effects of explicit observational goals (memorize versus form impression) on the unitization process. As mentioned previously, Cohen and Ebbesen found qualitative differences in behavior unitization as a result of their observational-goal manipulation. Cohen and Ebbesen also reported quantitative effects; a memorization goal led participants to discriminate more meaningful actions in the observed behavior than did an impression-formation goal. If changes in unitization can indeed be initiated without conscious intention and choice, then Ratcliff and Lassiter (2007) expected the goal-priming manipulation to yield shifts in unitization rate and pattern similar to those obtained by Cohen and Ebbesen using a more overt observational-goal manipulation.

Although Cohen and Ebbesen (1979) and Lassiter et al. (2000) both found evidence of qualitative differences in behavior unitization as a function of observational goal, the analyses that were reported did not allow for conclusions to be drawn about the precise nature of these differences. That is, the global patterns of information extracted by perceivers with different observational goals were shown to diverge, but a more detailed examination of what specific information was or was not registered by particular groups of perceivers was not performed. A second purpose of the Ratcliff and Lassiter (2007) research, then, was to examine more precisely the nature of differences in information pick-up as a function of observational goal.

Toward that end, the behavior sequence that Ratcliff and Lassiter (2007) had participants view (in Study 1) included a segment showing a young woman committing a *faux pas* – spilling a drink on herself. Prior research had shown that such pratfalls can lead people to evaluate an undistinguished person more negatively (Aronson, Willerman, & Floyd, 1966). Ratcliff and Lassiter (2007) hypothesized, however, that such an act might only be of particular relevance to perceivers who have a goal of forming an impression of the person, as was the case in the Aronson et al. (1966) research. For perceivers with the alternative goal of learning or memorizing the task the person is performing, an accident of this sort might be largely irrelevant.

Based on this line of reasoning, Ratcliff and Lassiter (2007) anticipated that evaluative reactions to the woman would be the most unflattering for participants who were nonconsciously pursuing an impression-formation goal. That is, these researchers thought that the act of “spilling a drink” and its implication that the woman is possibly clumsy would influence to a greater extent participants who were in fact automatically attempting to form an impression of her than those who were automatically attempting to learn or memorize what she was deliberately doing. Importantly, it was further hypothesized that the predicted difference in evaluations resulting from the priming manipulation would be a function, at least in part, of how participants actually unitized the behavior sequence. That is, Ratcliff and Lassiter (2007) predicted that participants primed with an impression-formation, as opposed to a memorization, goal would be more likely to register the drink-spilling incident as a meaningful action. It is also likely, they thought, that the observational goal of forming an impression would influence post-perception integration and elaboration processes as well (cf. Chartrand & Bargh, 1996). If this were indeed the case, Ratcliff and Lassiter (2007) expected that a mediation (path) analysis would reveal both a significant (direct) effect of the goal-induction manipulation on evaluations of the woman (indicative of a post-perception, elaboration contribution) and a significant (indirect) effect of how participants initially unitized her behavior (indicative of a perceptual contribution).

Ratcliff and Lassiter's (2007) results indicated that an act of will is not required for adjustments in the unitization process to be put into motion. Although careful debriefing confirmed the effectiveness of the nonconscious-goal-priming technique (i.e., there was no evidence that observers were consciously and deliberately pursuing either impression-formation or a memorization goal), differences in unitization rate and unitization pattern were found. In terms of unitization rate, the automatic activation of an impression-formation, as opposed to a memorization, goal led observers to identify fewer meaningful actions in the behavior sequence – a response comparable to that found in a previous study in which observational goals were manipulated via explicit instructions (Cohen & Ebbesen, 1979).

The priming manipulation also influenced evaluations of the woman depicted on the videotape (Study 1). Specifically, the impression-formation prime resulted in more negative evaluative ratings of her. Importantly, this effect was shown to be in part a function of how observers initially unitized or registered information from the behavior sequence. That is, the overall lower unitization rate and greater registration specifically of the woman's pratfall together contributed to the tendency of those primed with an impression-formation goal to react more harshly to the woman. These data demonstrated once again that in order to achieve a full understanding of social judgment phenomena, the important role played by variation in behavior perception should not be ignored, as was once advocated (Jones & Davis, 1965) and, in practice, is still the case more often than not.

Finally, observers' sense of how well they could remember what the woman on the videotape had done (Study 1) and their actual memory (Study 2) were also affected by the priming manipulation. Consistent with the findings of Cohen and Ebbesen (1979), observers primed with a memorization goal expressed more certainty with regard to being able to render a clear and accurate account of events that transpired in the behavior sequence and actually recalled more than did observers primed with an impression-formation goal. Notably, these confidence and memory results were no longer significant once the difference in unitization rate between the priming groups was partialed out. Assuming that confidence in one's ability to recount an observed event would be related to the amount of information picked up from the event, the confidence data, as well as the memory data, can be viewed as providing support yet again for the notion that the unitization process functions to regulate information gain from the observation of ongoing behavior, with a higher unitization rate indicative of greater action-related information gain.

Lassiter, Geers, and Apple (2002) noted that although learning a task and forming impressions are goals observers may select in the course of everyday interaction, there are certainly other significant goals or objectives that may frequently arise that could also influence observers' perception of social events.

They argued that the communication set observers adopt constitutes an important observational goal that should also systematically affect the manner in which ongoing behavior is unitized by perceivers. By communication set, Lassiter et al. (2002) meant whether people expect to pass on information gleaned from an observed event to another person after viewing it (transmitter set) or expect to hear more about the event from someone else after viewing it (receiver set, Zajonc, 1960).

Assuming that an ongoing stream of behavior represents a relatively complex target stimulus (thereby requiring simplification), Lassiter et al. (2002) anticipated, based on Gricean rules of conversation (Grice, 1975) and the extant literature on communication set, that individuals given a set to transmit information would unitize an observed behavior sequence at a grosser level than individuals given a set to receive information. That is, extracting the gist of the behavior as opposed to focusing on its minute details would seem to be the more appropriate perceptual strategy to use if one's observational goal from the outset is to construct a relatively concise and clear summary of information that could be easily communicated.

Lassiter et al. (2002) also included a control condition in which individuals received no communication-set instructions. The inclusion of this no-set control provided a baseline from which to assess the effects of both transmission and reception sets on the perception of ongoing behavior. Previous communication-set studies that have included such control conditions (e.g., Harkins, Harvey, Keithly, & Rich, 1977; Mazis, 1973) have generally reported that control participants respond much like receivers, suggesting that in most instances individuals tend to access more open and flexible cognitive structures (i.e., are not overly committed to a particular interpretation) when organizing information (cf. Harkins et al., 1977). In terms of level of unitization, then, Lassiter and colleagues (2002) predicted that transmitters would unitize more grossly than both receivers and controls, with the latter two groups not differing. Finally, they predicted no differences in unitization pattern across the three conditions. This prediction followed from the assumption that the aim of transmitters is to convey a simpler, more succinct picture, but not one that is fundamentally different in content from receivers or controls.

Lassiter et al. (2002) reported on three experiments that supported the abovementioned hypotheses. In addition, other data (Study 2) showed that transmitters express less certitude in the social judgments they make than nontransmitters. One might have thought that people who have to communicate information to others would feel relatively certain about that information. This finding, though, is consistent with the results of previous communication-set studies that indicate that transmission tuning is associated with an avoidance of large amounts of information (e.g., Cohen, 1961; Mazis, 1973). Assuming that confidence is positively related to the total amount of information that is available to make a judgment (cf. Newtson, 1973), the lower confidence of transmitters is not so surprising.

Lassiter et al. (2002) also found in Studies 3 and 4 that a set to transmit produces a less positive affective reaction to the observed event. Such a result fits with the notion that transmitters are extracting less information overall from the event and thus less positive habituation is occurring (positive habituation refers to the process whereby simply gaining a greater amount of information about a stimulus renders that stimulus more affectively pleasing; cf. Gordon & Holyoak, 1983: Lassiter & Stone, 1984). On the practical side, this demonstration of a communication set–affective reaction link suggests that when people plan to tell others about their experience with some stimulus, their feelings about that stimulus may be altered by the mere fact that they are later going to convey those feelings to others.

Finally, also consistent with the notion of diminished information gain resulting from a transmission set was the finding that transmitters recalled fewer actions from the observed event than nontransmitters (Study 3). This result would seem to be at odds with data reported by Harkins et al. (1977) that indicated that transmitters (relative to receivers and controls) made *fewer* recognition errors following the viewing of a videotaped event. However, closer inspection of Harkins et al.'s (1977) methods reveals that their findings and the findings of Lassiter et al. (2002) are in fact consistent with one another. That is, Harkins et al.'s recognition items focused on participants' memory for nonaction information in the videotape – namely, the correct paired associate to 15 different stimulus words. Lassiter et al. (1988, Study 2) found that whereas a gross (relative to a fine) level of unitization impaired memory for action-related information in a videotaped sequence, it *facilitated* memory for nonaction-related information. Thus, Harkins et al.'s recognition data may be indicative that transmitters in their experiment (like Lassiter et al.'s, 2002) were unitizing the observed videotape less finely than either receivers or controls.

## *Prior Expectations*

It is well established that prior expectations can influence social evaluations that are based on behavioral observation. What is less certain is whether such effects are due to selectivity at the point of initial perception/registration of information or at the point of subsequent encoding of the information into memory. According to the memory-encoding account, both information that is consistent and inconsistent with an expectation is initially registered or picked up; however, consistent information is weighted more heavily in the subsequent memory encoding and interpretation of the observed behavior (cf. Anderson & Pichert, 1978). In contrast, a perception-based account argues that the initial perception of behavior is inherently selective, and that observers' expectations lead them from the outset to be more likely to register or pick up consistent, rather than inconsistent, information (cf. Massad et al., 1979; Zadny & Gerard, 1974). Lassiter, Lindberg, Ware, Irvin, and Ratcliff (2009) conducted multiple experiments to provide evidence for the tenability of the perception-based account.

In an initial experiment, participants viewed a 9-min videotape with the sound muted that depicted an undergraduate female engaged in a conversation with an unseen male. The camera was zoomed in so that only the face of the woman was visible to observers. The woman was instructed to alter her facial expression at various points in the conversation. In the first minute or so, her expression stayed relatively neutral but from then on her facial neutrality was punctuated with expressions that were sometimes negative and sometimes positive (see Figure 10.4). The degree of negativity or positivity of her expressions varied from subtle to blatant.

The behavior sequence was presented on a computer monitor and participants were instructed to divide the behavior into perceptual units by pressing the space bar on the computer keyboard whenever in their judgment the woman made a meaningful expression or gesture. Participants' button-pressing responses were recorded so that both the number and exact location of the meaningful actions they registered could be precisely determined. Prior to viewing and unitizing the behavior sequence, participants were instructed to choose one of five options that were presented on the computer so that they could learn a bit of information about the woman that they would soon view on the videotape. This procedure permitted Lassiter et al. (2009) to manipulate participants' prior expectation of the woman. Participants learned that the woman was considered friendly by others, was considered unfriendly by others, or was a student and nothing more.

Following the videotape presentation, participants responded to five items designed to assess their evaluations of the woman they had observed. These items were combined to form a single evaluation index, with higher numbers indicating a more favorable reaction to the woman.

An analysis performed on the number of meaningful actions registered by participants revealed no significant effect of the prior-expectation manipulation. Examination of the specific actions that were registered as meaningful, in contrast, showed marked differences at several points as a function of prior expectation. For example, the left-hand image of Figure 10.4 was registered by 43% of participants receiving the "unfriendly" expectation, by 37% of those receiving the "student" expectation, and by only 13% of those receiving the "friendly" expectation, whereas the right-hand image of Figure 10.4 was registered by 32% of the participants receiving the "unfriendly" expectation, by 24% of those receiving the

FIGURE 10.4 A relatively negative (left) and a relatively positive (right) facial expression extracted from the videotaped behavior sequence used in several studies examining a perception-based account of expectancy effects (Lassiter et al., 2009).

"student" expectation, and by a high of 46% of those receiving the "friendly" expectation.

An analysis of the evaluation index revealed a significant effect of the expectation manipulation. The "friendly" expectation produced the most favorable reaction to the woman, followed by the "student" expectation, and the "unfriendly" expectation. Follow-up regression analyses showed that participants' differential registration of positive and negative actions mediated the effect of prior expectations on their evaluations of the woman, thus supporting a perception-based account. That is, evaluations were driven by the particular information observers selected from the behavior sequence rather than it being the case that the same information was registered by all observers, which would mean that their disparate evaluations could only have resulted from post-perception interpretation or memory processes.

A second experiment was conducted to further establish the plausibility of a perceptual interpretation of expectancy effects. Seven actions preferentially registered by either the "friendly" or "unfriendly" expectation group in Study 1 were presented as a brief slide show to two new groups of participants. After viewing the slide presentation, participants in both groups completed the same evaluative items used in Study 1.

Analysis of the combined evaluation index revealed that new participants viewing seven slides from the behavior sequence that were preferentially registered by the "friendly" expectation group in Study 1 developed a significantly more favorable impression of the woman than did participants viewing seven slides from the behavior sequence that were preferentially registered by the "unfriendly" expectation group in Study 1.

Together these two studies provide considerable support for a perception-based explanation of the effect of prior expectations on evaluations of people that are derived from the observation of their behavior. In Study 1, individuals anticipating positive (negative) behavior from an observed woman indeed preferentially registered positive (negative) actions from a sample of her behavior. This differential perception/registration of information in turn contributed to disparate evaluations of the woman. The findings of Study 2 confirm that the different actions perceived/registered by the divergent expectation groups in Study 1 truly contained different information capable of conveying very distinct impressions of the woman, rather than being actions that were simply interpreted in a manner that was consistent with the prior expectation.

One potential criticism of these initial experiments is that the act of unitizing the woman's behavior had a reactive effect on participants, which alone or in combination with the expectation manipulation could have produced the differential evaluations observed. To address this possibility, a third experiment was conducted that was identical to the first except that only half of the participants unitized the woman's behavior; the remaining participants simply observed the videotaped presentation. The results revealed that the unitizing task is nonreactive. That is, the expectation manipulation affected evaluations to the same extent as in Study 1 regardless of whether participants expressly unitized or not (cf. Newtson & Engquist, 1976; Zacks et al., 2001).

Another aspect of the preceding studies to which critics might object is the heavy-handed manipulation of expectations. That is, participants were explicitly informed that the woman they would view on videotape is friendly, unfriendly, or simply a student. It is not implausible, then, that the effect of the expectation manipulation on evaluations of the woman is the result, at least in part, of demand characteristics (Orne, 1962). To rule out such a possibility, Lassiter et al. (2009) conducted a fourth experiment in which they replaced the explicit, verbal-based manipulation of expectations with a nonverbal, more subtle manipulation. Specifically, prior to observing the full videotape of the woman, participants viewed a very brief (4-s) video clip that depicted her with a slight positive, slight negative, or neutral expression on her face, the rationale being to allow participants to get a look at the person they would be watching later in the experiment. Given the body of work that shows observers can quickly form impressions even from "thin slices" of a person's behavior (Ambady, Bernieri, & Richeson, 2000), Lassiter et al. (2009) hypothesized that this alternative manipulation would similarly produce "friendly" or "unfriendly" expectations about the woman but without engendering the same possibility of demand characteristics associated with the previous manipulation. The results showed that this "thin-slice" manipulation of expectations produced the same effect on evaluations of the woman as did the more overt manipulation used in the preceding studies.

Although the foregoing experiments clearly established that perceptual processes contribute to the effects of prior expectations on evaluations, it is still possible that memory-encoding processes may play an equally, if not more, important mediating role. A fifth experiment, then, included a measure of the extent to which participants recognized various points from the observed videotaped sequence. Once again, the expectation manipulation affected both participants' initial unitization and subsequent evaluations. However, there was no effect of the expectation manipulation on participants' memory for the woman's behavior nor was there a significant correlation between their memory performance and evaluations.

In a sixth experiment, Lassiter et al. (2009) directly manipulated memory-encoding processes to test further their possible role in mediating the effects of prior expectations on evaluations. As in Study 1, participants learned that the woman was considered friendly by others, was considered unfriendly by others, or was a student and nothing more. Additionally, half of the participants were further instructed that they would be counting backward from 500 while viewing the videotape to simulate real-life situations in which people "multitask" (e.g., driving and talking on a cell phone). The real purpose of the counting task was to disrupt participants' memory encoding of what they observed. Importantly, the counting task has been shown previously *not* to interfere with the initial perception or pick-up of information (e.g., Lassiter, 1988).

Following the videotape presentation, participants completed the same evaluation index used in the previous studies. Participants also completed a memory task that required them to choose which of two 4-s video segments actually appeared in the full videotape they had observed. The task comprised 10 pairs of segments, with one segment of each pair taken from the observed behavior sequence and one taken from a portion of similar videotape that the participants did not see.

The memory data confirmed that the counting task was successful in disrupting memory-encoding processes. In fact, participants in the counting condition achieved no better than chance accuracy at the task, and were significantly worse than their no-counting counterparts. However, the evaluation index revealed only a significant effect of the expectation manipulation. The "friendly" expectation produced the most favorable reaction to the woman, followed by the "student" expectation and the "unfriendly" expectation. The absence of any effect of the counting task on evaluations is contrary to what would be predicted based on the memory-encoding account of expectancy effects.

In contrast, the perception-based account received support from an analysis showing that the expectation manipulation significantly influenced the extent to which participants initially registered positive and negative information from the sequence. The "friendly" expectation produced a higher selection of positive vs. negative information than did the "student" expectation and the "unfriendly" expectation. Moreover, follow-up regression analyses showed that participants' differential registration of positive and negative actions partially mediated the effect of prior expectations on their evaluations of the woman.

In a seventh experiment, Lassiter and colleagues (2009) set out to provide even stronger support for a perception-based account of the effect of expectations on evaluations. An important limitation of the preceding studies is that the process of perceptually registering information was never directly manipulated, and thus firm conclusions about expectancy effects being rooted in initial perceptual processes rather than post-perception, cognitive operations cannot be drawn. In addition, the measure of perceptual registration in these studies consisted of participants pressing a button to indicate when something informative happened in the video sequence they observed. Notwithstanding documentation of its reliability and validity as an indicator of the perceptual segmentation of ongoing behavior (noted earlier), some may consider the unitization technique to be a measurement tool that is influenced not only by perceptual processes but also to some extent by conceptual processes, thus further rendering the evidence for perceptual mediation equivocal.

To circumvent both of these drawbacks of the previous research, Lassiter et al. (2009) used a different methodology to evaluate the perceptual mediation account of expectancy effects: one that permitted them to both manipulate the perceptual system and better demarcate the contribution of perceptual and conceptual processes. The model for this improved methodology was derived from investigations demonstrating that different processing systems can be selectively interfered with and that interference with a particular system diminishes the impact of that system on subsequent judgment (e.g., Claypool & Carlston, 2002; Ratcliff, Lassiter, Schmidt, & Snyder, 2006). In their penultimate investigation, Lassiter et al. (2009) used this interference approach to provide more unequivocal (i.e., experimental) evidence that the fundamental nature of expectancy effects based on behavioral observation is largely perceptual.

Participants received either the friendly expectation or unfriendly expectation used previously prior to viewing the same target video presented in the preceding experiments. Orthogonal to the expectancy manipulation, participants in a perceptual interference condition were shown a photograph of a male face (said to be the person to whom the woman in the video was speaking) and were instructed to visualize that image in their minds as they simultaneously watched the video sequence. Participants in a conceptual interference condition were also shown the photograph but were not asked to visualize the image. Instead, these participants were instructed to count backwards from 500 for the duration of the video (see description of Experiment 6 above). Prior research by Ratcliff et al. (2006) had established the effectiveness of these two types of interference tasks, with the former selectively disrupting perceptual processing (initial registration of information from the observed event) and the latter selectively disrupting conceptual processing (subsequent memory encoding and elaboration of that information).

The results revealed that in the conceptual interference condition the effect of the expectation manipulation was once again significant, despite that fact that an assessment of memory (see Experiment 6 above) indicated that recognition performance was worse in this condition than in the perceptual interference condition. However, in the perceptual interference condition the effect of the expectation manipulation was nonsignificant for the first time in this series of studies. Thus, whereas a conceptual interference task (counting backwards) that is widely used by researchers to partially disrupt higher-order reasoning processes did not diminish the effect of expectations on evaluations, a perceptual interference task (visualizing a face) completely eliminated it. Given that the literature on mental imagery (e.g., Kosslyn & Thompson, 2003) generally shows that imagining and perceiving draw on an overlapping pool of resources (at least when in the same sensory modality, which was the case in the present experiment), these results seem to indicate that the normal perceptual processing that would usually produce expectancy effects was sufficiently altered by the imagery task to prevent them from occurring.

An eighth and final study by Lassiter et al. (2009) attempted to pit a perceptually based interpretation of expectancy effects against a more conceptually based interpretation (emphasizing the dominant role of post-perception, construal processes as the ultimate determinant of divergent evaluations associated with different prior expectations) in a manner that allowed only one clear winner. The approach taken mimicked one first used by Lassiter and Geers (2005). Participants were asked to view one of three new videos of a different woman interacting with an unseen other. Similar to previous studies, in one version the woman's facial expressions oscillated between positive, neutral, and negative. In a second version her expressions were mildly but consistently positive. In the final version her expressions were mildly but consistently negative. Prior to the video presentation, participants once again received either the friendly or unfriendly expectation. After viewing the video, participants rated the woman on a new set of evaluative items.

If a conceptually based interpretation of expectancy effects is correct, Lassiter et al. (2009) anticipated that evaluations would be assimilated to the expectation more or less to the same extent regardless of the perceptual content of the video.

However, if a perceptually based interpretation of expectancy effects is correct, they anticipated that evaluations would be substantially constrained by the perceptual content of the video. More specifically, the effect of the expectation would be greatly amplified when the perceptual content was largely congruent with (matched) the expectation, but would actually be *reversed* from the typical pattern (i.e., a contrast effect) when the perceptual content was largely incongruent with (opposite) the expectation.

The data were clear: When the perceptual content of the video was a mix of positive, neutral, and negative facial expressions, the typical difference in evaluations was found as a function of expectation. That is, the friendly expectation yielded more positive evaluations than did the unfriendly expectation (difference = .55). When the perceptual content was largely congruent with the expectation (i.e., in the friendly expectation–positive content and unfriendly expectation–negative content conditions), the effect of the expectation on evaluations was greatly increased (difference = 1.69). And most critically, when the perceptual content was largely incongruent with the expectation (i.e., in the friendly expectation–negative content and unfriendly expectation–positive content conditions), the typical difference in evaluations as a function of expectation was dramatically reversed (difference = –.72). Overall, the programmatic series of studies conducted by Lassiter et al. (2009) indicate that perceptual processes play an important role with regard to how expectations influence social evaluations based on behavioral observation.

Before moving on to the next set of investigations into top-down influences on the perception of ongoing behavior, it is important to note that variation in behavior perception can act not only as a mediator of expectancy effects as shown above, but also can assume the role of a moderator of such effects. Specifically, Geers and Lassiter (1999) demonstrated that affective expectations ("people's predictions about how they will feel in a particular situation or toward a specific stimulus," Wilson & Klaaren, 1992, p. 3) can produce corresponding or contrasting affective experiences depending on how finely they unitize a stimulus event. That is, Geers and Lassiter found that when participants unitized grossly (thus registering relatively minimal information from the observed event), they were less likely to detect discrepancies between their expectation and the stimulus, and so their evaluations assimilated toward the expectation. However, when participants unitized finely (thus registering relatively maximal information from the observed event), they were more likely to notice discrepancies between their expectation and the stimulus, which led their evaluations to contrast with, rather than assimilate toward, the expectation.

### *Prejudicial Attitudes*

Up to this point, the extent to which observers seek to extract information from ongoing behavior has focused on their desire or need for information as a means of aiding comprehension of the behavior. However, Hogue and Atkinson (1989) argued that the desire for information might also be viewed in affective terms. For example, how does a person who loathes ice hockey and is not really interested in viewing the action manage to suffer through “hockey night” while visiting with friends in Canada? An effective strategy to avoid information in this instance would be to use a very gross level of unitization so that the least amount of the undesirable information is extracted. (A better strategy, obviously, would be to remove oneself from the situation entirely, but such a strategy would be a terrible affront to one’s host.) Based on this line of reasoning, Lassiter, Ratcliff, Apple, Beers, and Hadley (in preparation) hypothesized that people with prejudicial attitudes toward certain social groups would unitize the behavior of a member of that group more grossly than would non-prejudiced individuals. That is, perceivers who hold a negative view of the group to which an observed other belongs would likely not be interested in information about such a person, and as a result would employ a lower rate of behavior unitization to avoid such information to the extent possible (cf. Hogue & Atkinson, 1989).

In an initial test of this hypothesis, white participants viewed and unitized one of two 5-min, single-actor behavior sequences. Both sequences depicted the same behaviors, but in one case the male actor was white and in the other he was black. In an earlier, unrelated group testing session all subjects had completed the Modern Racism Scale (McConahay, 1986). A median split was performed on the distribution of scores on this scale to produce a group of participants relatively high and low in their prejudice against blacks.

Consistent with Lassiter et al.’s (in preparation) expectations, the results showed that high- and low-prejudice participants unitized the white actor’s behavior to the same extent; however, high-prejudice participants unitized the black actor’s behavior into fewer actions than did low-prejudice participants.

This study showed that perceivers employed a lower rate of unitization, and thus presumably extracted less information, when viewing the behavior of another for whom they have a negative attitude. One implication of this research is that it may be especially difficult for prejudiced individuals to gather adequate information about the targets of their prejudice; information that could potentially alter their negative views.

In a second study, Lassiter and his colleagues (in preparation) had participants view a single behavior sequence, with some participants led to believe the person they were viewing was gay or straight. High and low prejudicial attitudes toward gays were assessed using the Attitudes Toward Lesbians and Gay Men (ATLG) Scale (Herek, 1988). The same results as found in the first study were replicated, demonstrating that the effect occurs when exactly the same person and behavior are observed, and when the prejudice is not based on race but on sexual orientation.

A third experiment was conducted to examine whether the effect generalized to instances of class prejudice. The method of Study 1 was replicated with the addition of a condition in which information was provided that identified the white actor as being a welfare recipient. Participants scoring low on the Modern Racism Scale again unitized the observed behavior into relatively finer units regardless of whether the actor was black, white, or a white welfare recipient. Participants scoring high on the Modern Racism Scale once again unitized the behavior of the black actor into fewer actions than they did the behavior of the white actor.

In addition, these high-prejudice individuals also unitized the identical behaviors of the white actor more grossly when they were informed that he was receiving welfare. It appears that individuals with prejudicial attitudes toward blacks are motivated to avoid information gain about a lower-class white person as well as a black person.

To establish more clearly that the variation in behavior perception observed in the preceding studies indeed reflected real differences in information gain, Lassiter et al. (in preparation) conducted a fourth study in which a memory measure was included. The design was identical to that of Study 1, with participants additionally being asked following the video presentation to remember all they could about what the actor did. The unitization data exactly replicated the pattern found previously: high- and low-prejudice participants unitized the white actor's behavior comparably; however, high-prejudice participants unitized the black actor's behavior less finely than did low-prejudice participants. The free recall data mirrored this pattern very closely. That is, no recall differences emerged between high- and low-prejudice participants who viewed the white actor, but the former recalled significantly fewer of the black actor's behaviors than did the latter. These data, then, confirm the contention that prejudicial attitudes indeed result in the extraction of less information from the observed behavior of persons to whom such attitudes are directed.

As noted above, Lassiter et al. (in preparation) framed their hypothesis about the effects of prejudicial attitudes on the perception of ongoing behavior in motivational/affective terms. That is, the argument they make is that highly prejudiced individuals are not inclined to put in the effort to maximize their information intake about a person who belongs to a group that they view very negatively; indeed, they are disposed to actively avoid acquiring such information (cf. Hogue & Atkinson, 1989). An alternative interpretation of the results presented above, however, is that high-prejudice individuals were relying on stereotypes (i.e., schemas) to a greater extent and it was this rather than a motivation to avoid gathering information about a person who elicits their contempt that was responsible for their use of a grosser level of behavior unitization. Recall that at the outset of this chapter we noted that the possession of prior information or a schema in and of itself can lead to a grosser level of unitization because the need for additional information gain is not as great in such circumstances (cf. Markus et al., 1985). To rule out this possibility, a fifth study was conducted in which participants viewed an actor they believed was an ingroup or outgroup member based on an entirely arbitrary distinction (cf. Tajfel, Flament, Billig, & Bundy, 1971).

Experimental participants were assigned to one of two arbitrary groups: the red group or the blue group. Although group assignment was random, participants were led to believe that assignments were based on their artistic preferences for abstract paintings (cf. Tajfel et al., 1971). Participants in a third (control) group were told nothing about any group designation. All participants then viewed and unitized a 6-min behavior sequence of an actor that experimental participants (but not controls) would perceive as belonging to the red group (because he was wearing a red vest that signified membership in that group). Thus the actor would be viewed as an ingroup member for participants in the red group (who were asked to don a red vest for the duration of the experiment) and as an outgroup member for participants in the blue group (who were correspondingly asked to don blue vest for the duration of the experiment).

Consistent with the motivational/affective explanation proffered by Lassiter et al. (in preparation), participants who believed the actor was an outgroup member segmented her behavior into fewer action units than participants who believed the actor was an ingroup member or than participants who received no group information. The latter two groups unitized the observed behavior into a similar number of actions, which is important because it indicates that the "outgroup" condition lowered unitization rate rather than it being the case that the "ingroup" condition raised it. The alternative, schema-based explanation is implausible in this instance because participants could not logically possess any prior information that would tend to lower their need for information about the person designated a member of the arbitrary outgroup.

In a final investigation, Lassiter et al. (in preparation) examined the extent to which the quality, rather than the quantity, of information extracted during behavior observation is affected by prejudicial attitudes. A video segment – approximately 4 min in duration – was created in which a male college student depicted in his dorm room engages in some behaviors associated with the gay stereotype (e.g., dusting with a feather duster, pruning a plant). Participants high and low in prejudice toward gays (based once again on their responses to ATLG; Herek, 1988) viewed and unitized this sequence under one of two conditions: Half were informed that the student in the video was gay and half were informed he was straight. The primary measure of interest in this study was the extent to which perceivers registered the specific actions associated with the gay stereotype.

The pattern of results was most interesting: High-prejudice participants registered an equivalent number of stereotypic actions regardless of whether they were under the assumption that the observed student was gay or straight. Low-prejudice participants, on the other hand, registered more stereotypic actions when they assumed the student was straight than when they assumed he was gay. One interpretation of these findings suggested by Lassiter et al. (in preparation) is that low-prejudice individuals were attempting to be egalitarian in selectively avoiding information that coincided with the gay stereotype when the student was presumed to be gay (Devine, 1989). However, further investigations will need to be conducted to evaluate the tenability of this and other possible explanations for Lassiter et al.'s (in preparation) sixth study.

Although they measured reasoning processes and not perceptual processes, a separate study by Lassiter, Apple, and Munhall (raw data) provides additional support for Lassiter et al.'s (in preparation) more general contention that prejudicial attitudes tend to diminish motivation to engage in thorough processing of information associated with persons to which those negative attitudes apply. Specifically, Lassiter et al. (raw data) hypothesized that prejudice could influence the extent to which individuals fall prey to the correspondence bias (Gilbert & Malone, 1995). Gilbert and Malone (1995, p. 21) define the correspondence bias as "the tendency to draw inferences about a person's unique and enduring dispositions from behaviors that can be entirely explained by the situations in which they occur." Gilbert and his colleagues (e.g., Gilbert, Pelham, & Krull, 1988) have demonstrated that this bias is most likely to occur when perceivers are unable or *unwilling* to engage in the cognitive effort they argue is necessary to correct an initial, spontaneous dispositional attribution for an observed other's behavior. That is, according to Gilbert et al., perceivers automatically and with little effort initially infer a dispositional cause for a person's actions. Assuming sufficient cognitive resources are available and *motivation is high*, perceivers subsequently engage in more deliberate, controlled, and effortful processing to correct this initial inference by taking into account possible situational influences on the behavior.

Drawing on Lassiter et al.'s (in preparation) argument that prejudicial attitudes lead to a selective reduction in motivation to process effortfully and thoroughly, Lassiter et al. (raw data) predicted that individuals with low prejudice toward blacks would be no more likely to manifest the correspondence bias for an observed black actor than for an observed white actor. However, they anticipated that individuals with high prejudice toward blacks would be more likely to manifest the correspondence bias when making attributions about a black as opposed to a white actor.

To empirically evaluate their hypotheses, Lassiter et al. (raw data) employed procedures that closely followed those used by Gilbert et al. (1988). Participants watched seven silent video clips of a female target discussing various topics with a stranger. In five of these clips, the target appeared very anxious. Half of the participants were informed that during the five "anxious" clips, the target was discussing anxiety-inducing topics (e.g., her personal failures). The remaining participants were told that in all seven clips the topics of discussion were instead relaxation-inducing (e.g., favorite hobbies). In addition, for half of the participants the female target was black and for other half she was white. After viewing the video clips, participants rated on a 13-point scale how dispositionally anxious they judged the target to be.

Consistent with Lassiter et al.'s (raw data) predictions, the failure to correct for situational constraints on behavior (i.e., the correspondence bias) was greater in the high prejudice/black actor cell than in the high prejudice/white actor, low prejudice/black actor, or low prejudice/white actor cells. This study, then, provides converging evidence that the motivation to process effortfully and thoroughly is indeed compromised when information concerning persons against whom we are highly prejudiced is encountered. And it can be concluded from the totality of the research on this topic that the effect impacts both the initial registration of information (perceptual processes) and the later elaboration of that information (conceptual processes).

## CONCLUSION

We believe that a complete understanding of social behavior and social judgment requires a concerted effort to explicate how it is that we make sense of the stream of information that is made available as perceived others go about the business of behaving. The field of social psychology has been dominated for decades now by theoretical frameworks that emphasize post-perception, cognitive operations as the royal road to understanding social psychological phenomena. As this volume attests, however, the tide may be turning and an ever-growing recognition of the important role of perception in our social lives promises advances in our knowledge of the nature of social behavior and social judgment for years to come. We hope that this chapter's review of recent research demonstrating top-down influences on the perception of ongoing behavior contributes in some small way to this exciting new focus in social psychological scholarship.

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# 11

# A New Look at Person Construal: Seeing Beyond Dominance and Discreteness

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> The richest and most elaborate affordances of the environment are provided by other animals and, for us, other people. (J. J. Gibson, 1979/1986, p. 135)

In the ecological approach to visual perception, J. J. Gibson redefined visual perception in reciprocal terms, an important departure from the theories of the time. The visual perception of objects, he argued, is bound to the objects' inherent affordances, or the interaction possibilities between the perceiver and the object of perception (Gibson, 1979/1986). Gibson's functional perspective had, and continues to have, a sweeping impact on theories of visual perception. Yet with a few notable exceptions (e.g., McArthur & Baron, 1983; Zebrowitz & Collins, 1997), rarely have researchers considered how social affordances fundamentally change the perceptual process, a notion to which Gibson alluded but about which little progress has been made. To be sure, objects of perception that afford social interaction (i.e., other people) are likely to be among the most important targets to be visually perceived. By this reckoning, few perceptual tasks are as critically important as the mandate to perceive the characteristics and identities of others from the extant visual cues availed to the perceiver. It is these very percepts that implicate the likely course of interpersonal interaction. Social perception, or person construal, may therefore be characterized as an index of social affordance insofar as the early perception of person characteristics has a profound and lasting impact on subsequent attitudes, judgments, and interactions (McArthur & Baron, 1983).

Given this importance, it is unsurprising that a considerable amount of research has focused on the task of perceiving others. Until recently, however, social psychological research investigating "person perception" has focused almost exclusively on observers' ability to discern traits and dispositions from written behavioral descriptions. The application of ecological theory to person perception has had a similar focus – the perception of traits with an emphasis on the downstream consequences thereof. While the perception of other people's traits is undeniably important, perceiving others routinely begins by processing visual cues to identity and thus involves lower-level *visual* perception. Theoretical and empirical work examining the boundary between low-level visual processes and higher-level interpersonal dynamics began only recently. Moreover, the recognition that social factors may contextualize the visual perception of cues to identity is scarcely mentioned in existing literature.

In this chapter we will explore how social categories and the cues that convey them contexualize the visual processing of others, affecting not only the ultimate perception but also the process by which that percept is achieved. First, we will situate person construal within a broader perceptual framework and argue that social categories and visual cues serve as contextual information for visual perception. (We will use the term "person construal" to refer to the visual perception of other people. This phrase distinguishes our meaning from the more commonly used "person perception," which is typically used in reference to perceiving traits and dispositions.) Then we will review evidence that challenges two implicit but prevalent assumptions regarding the nature of person construal – dominance (i.e., that when perceiving individuals, one identity must dominate perception, such as race winning over sex) and discreteness (i.e., that social categories are ultimately perceived in a binary, all or nothing, fashion). Instead, we will argue that person construal is best characterized as a continuous process in which the representation of social category membership is continuously updated in real time. From this perspective, person construal never fully achieves discrete representation of social categories in working memory, but rather manifests in a dynamic probabilistic manner.

## PUTTING CONTEXT IN CONTEXT

To say that context affects visual perception is not a controversial statement. Indeed, vision scholars have long understood that the immediate context surrounding one's visual focus dramatically alters the perception of the focal stimulus. Many classic visual illusions emerge precisely because of the impact of visual context, often the space immediately surrounding the object of perception, having an inexorable effect on basic visual perception. Consequently, perception is swayed even when an observer is fully aware of the biasing impact that context is exerting. The Ebbinghaus (or Titchener) illusion is a perfect example. In spite of the fact that the center circles are identical in Figure 11.1, the perception of relative size is irrevocably influenced by the surrounding context. When it comes to visual perception, context matters.

Such effects extend far beyond the perception of physical parameters, and instead recruit prior knowledge to sway perception. Take the words appearing in Figure 11.2a, for example. When one focuses on the ambiguous middle letter in isolation from the first and last letters, it is readily apparent that the two are identical. Yet when viewing each letter within the context of a word, the inclusion of the lexical context effortlessly transforms the ambiguous letter into an "H" to complete the word "THE," but into an "A" to complete the word "CAT" (see also

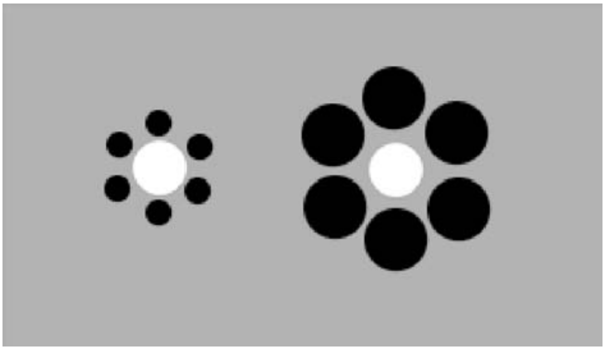


FIGURE 11.1 The Ebbinghaus illusion: The black circles surrounding the center white circle exert an inexorable effect on observers' perception of the size of the white circle, even though the two white circles are identical.

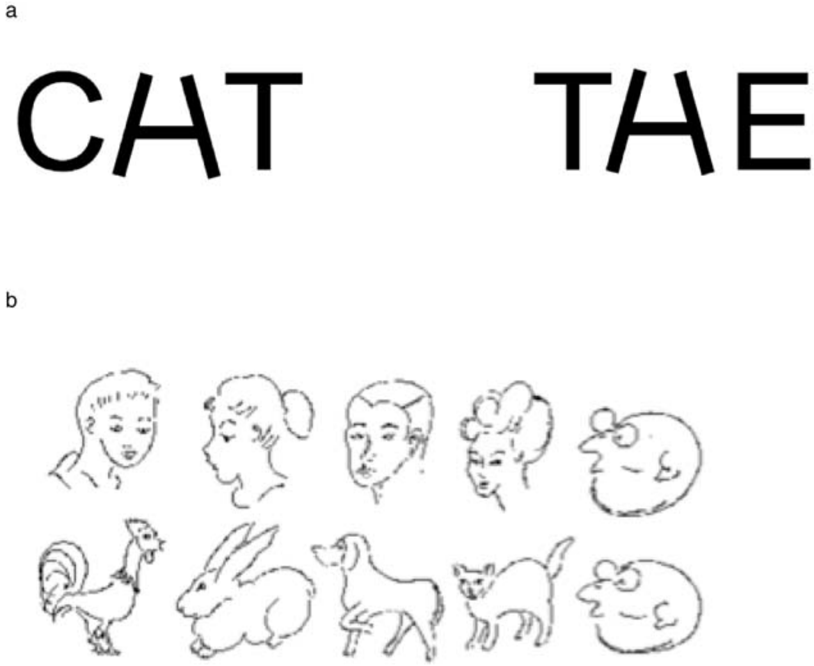


FIGURE 11.2 Ambiguous figures: (a) The lexical context in each word leads to a different interpretation of the middle character (described in Spivey, 2007). (b) The conceptual context in each row leads to a different interpretation of the final picture (from Bugelski & Alampay (1961), copyright 1961, Canadian Psychological Association; permission granted for use of material).

Spivey, 2007). In a seminal study, Bugelski and Alampay (1961) demonstrated that conceptual context can similarly affect visual perception. When an ambiguous figure such as the final image in Figure 2b was presented within the context of human faces, it was more likely to be interpreted as a bald man; when the same figure was presented within the context of other animals, in contrast, the same figure was more likely to be interpreted as a rat (see also Lassiter & Geers, 2005 and Chapters 4 and 10 in this volume for a more comprehensive discussion of these and similar effects). Thus, the notion that contextual information, be it physical or conceptual, can affect visual perception summons widespread support throughout the vision and cognitive science community.

Unlike the widespread embrace of the effect of context on the visual perception and interpretation of objects, the notion that *social* context can exert an analogous impact and fundamentally alter low-level aspects of visual perception provokes much skepticism. In fact, such notions have received a lukewarm reception, at best. Before describing some of the early studies that support just this sort of contextual modulation, it is instructive to consider what exactly constitutes social context. From a Gibsonian perspective, social context may be thought of as any extraneous information about a social target within the visual field. This perspective holds that, although inherently extraneous, such information can nevertheless guide basic perception because it has interpersonal or functional relevance. Social context may therefore include things such as social category information (i.e., one's sex, race, or age), perceptual cues that are diagnostic of a social category (e.g., sexually dimorphic cues in the face or body), or even the mere presence of a person. Any of these forms of social context may influence the perception of social and nonsocial stimuli alike.

For instance, evidence is accumulating that social context plays an important role in the perception of basic physical events. Shiffrar and her colleagues (Shiffrar, Kaiser, & Chouchourelou, in press), for example, have found that the presence of a person, as opposed to an object, can alter how, or even whether, biological motion is perceived. These effects are found in studies of the perception of apparent motion, the perceptual phenomenon in which the successive presentation of static images gives rise to the perception of smooth motion. This is the foundation for the appreciation of motion in films and flip books. When seen in rapid succession, a series of static pictures is perceived as dynamic motion.

As it turns out, not all apparent motion displays are created equal. In their studies, Shiffrar and her colleagues asked participants to judge the motion qualities (e.g., integrity or smoothness) of apparent motion displays in which two static images were separated by a fixed amount of time. Participants evaluated each sequence for the perception of motion and the quality (e.g., how smooth?). Predictably, the length of delay between the images powerfully influenced motion perception (replicating many prior studies). More interestingly, motion perception varied as a function of social context. When a motion, such as a punch, was directed toward a person, observers perceived the sequence "in motion"; when the motion was directed toward a non-human object such as a refrigerator, in contrast, observers did not. These data suggest that one form of social context – the presence of a person as the recipient of an action – altered low-level processing in the perceptual system (i.e., motion perception) and induced observers to perceive motion when, in fact, none actually existed.

Similar work has highlighted pronounced sensitivity for observers to detect coherent human motion, even under challenging visual conditions. These studies rely heavily on the well-documented ability of observers to perceive human motion even in the most impoverished of displays. In a seminal set of studies Johansson (1973, 1976) described a now widely used technique in which recordings were made of individuals engaged in various activities. Reflective material was affixed to the major joints of a target's body prior to filming so that when the films were replayed under altered illumination and contrast, only points of light were visible. This technique fully isolated the motion of the body. Observers of point-light displays can readily discern a range of social categories including sex category membership (Kozlowski & Cutting, 1997; Pollick, Kay, Heim, & Stringer, 2005), identity (Cutting & Kozlowski, 1976), behavioral intent (Runeson & Frykholm, 1981), and even emotion state (Pollick, Paterson, Bruderlin, & Sanford, 2001). These results and others highlight a strong visual sensitivity to infer interpersonal factors through the perception of human motion.

As it turns out, visual sensitivity to specific types of human motion can powerfully alter other aspects of visual perception. Observers of point-light displays, for example, are highly likely to accurately encode the emotion state of a display (Pollick et al., 2001), at times doing so without intent (de Gelder & Hadjikhani, 2006). The incidental perception of some emotions enhances observers' ability to detect human motion presented within a visual mask of other moving lights (Chouchourelou, Matsuka, Harber, & Shiffrar, 2006). In such tasks, participants' task is merely to determine whether a person is present or absent in a display that includes a "mask." Point-light walkers that moved with angry body motions were readily detected in the haze of moving lights (the mask). Point-light walkers that embodied different emotional states, however, were not. Arguably, these differences may be due to social affordances. The nature of potential interactions with another person varies with the target's emotion state. This makes the perception of some emotions, such as anger, more consequential. The social context of anger heightened perceptual sensitivity because of its interpersonal and functional relevance. Put simply, the visual perception of human motion is coupled to the functional importance of its perception.

In these examples, social context altered low-level aspects of visual perception. They highlight the critical role that social context plays in the basic perception of others. Findings from both neuroscience of vision and social cognitive modulation of perception provide evidence of how the neural subsystems underlying perception and cognition might collaborate to produce effects of social context on lower level perceptual judgments. The perception of human motion, for example, generally corresponds to increased activity in specific brain regions (e.g., posterior regions of the superior temporal sulcus, STS; Bonda, Petrides, Ostry, & Evans, 1996; Puce & Perrett, 2003). Interestingly, activation of this region occurs only when the motion is presented in an upright orientation that is familiar to perceivers (Grossman et al., 2000). Similar findings have been obtained for the perception of faces. For instance, the STS shows selective responses to various directions of eye gaze while humans observe either dynamic videos (e.g., Puce, Allison, Bentin, Gore, & McCarthy, 1998) or static images (e.g., Hoffman & Haxby, 2000) of the face. Cell recordings from STS neurons in non-human primates show that individual STS neurons show varying selectivity to specific flexions of the head or movements of the face in ways that have interpersonal significance, such as behavioral responses during dominance interactions (Hasselmo, Rolls, & Baylis, 1989). Thus, certain social context factors influence the neural processing of the face, and this influence likely carries functional importance. Also noteworthy is that bidirectional connectivity exists between brain areas that are sensitive to human motion (e.g., STS) and those associated with the processing of emotional content and threat (e.g., the amygdala; Amaral, Behniea, & Kelly, 2003), suggesting that emotion perception can modulate the perception of human motion (see also, Chouchourelou et al., 2006; Poirier et al., 2005). Collectively, these findings parallel the findings we have reviewed for social judgments, highlighting the neural mechanisms that may underlie such effects.

We propose that the effects of social context for visual perception may be more pervasive, extending beyond low-level visual perception to higher-level aspects of person construal. Visual cues to one aspect of a target's identity may serve as social context that, once perceived, affect other aspects of person construal such as categorization and evaluation. Thus, social context may alter within-target aspects of perception.

Some evidence supports this possibility. Emotional body motion, for example, heavily biases the perception of sex categories (Johnson, McKay, & Pollick, 2010; Johnson, Pollick, & McKay, 2008). Point-light displays depicting angry body motions are overwhelmingly judged to be men; those depicting sad body motions are more likely to be judged to be women, arguably because emotion expression is sex-stereotyped. Similarly, the perceiving sex category membership from static body cues altered the perception of body motion implicated in perceptions of attractiveness (Johnson & Tassinary, 2007) and sexual orientation (Johnson, Gill, Reichman, & Tassinary, 2007). In other work, the hairline displayed on an otherwise ambiguous race face alters the perception of the target's race category membership, leading an identical face to be perceived as belonging to different race categories (MacLin & Malpass, 2001, 2003). And finally, the internal morphology of a face, indicative of race category, heavily biases observers' perception of the target's skin tone (Levin & Banaji, 2006). In each of these cases, a visual cue to a domain of social relevance – emotion, sex, hairstyle, and race category, respectively – modulated perception of the target along another dimension even though the cues were largely orthogonal to the judgment task at hand. This suggestive evidence is consistent with the notion that visual cues to one aspect of person construal may contextualize the perception of cues to a different aspect of person construal.

This perspective has far-reaching implications. Virtually all social psychologists would acknowledge a privileged role for categorizing others by sex, race, and age (and possibly sexual orientation) for important interpersonal outcomes. Yet the predominant theories and empirical work investigating the perception of social categories have failed to appreciate fully how the perception of one category and the cues that convey it can contextualize the perception of other categories.

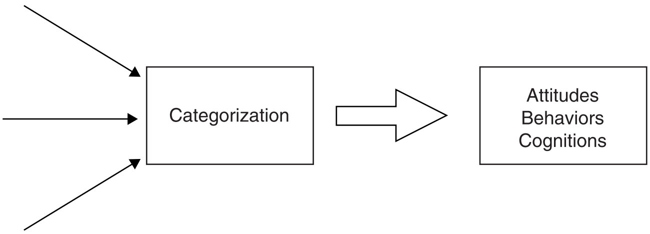
This has occurred for two reasons. First, in most social categorization research, extraneous social categories are typically held constant – either experimentally or statistically. Second, as we discuss in depth later, the presumption remains that social category representations have a pure and discrete, stand-still, and non-overlapping nature. These facets of prior research are both a blessing and a curse. Such research yielded a clear understanding of the downstream consequences of social categorization (e.g., stereotype activation), but it failed to inform our understanding of how the person construal process unfolds in time. We now turn our attention to these issues and discuss how social categories and the cues that convey them serve as social context for both the process and product of social perception.

## CATEGORIES AND CUES AS CONTEXT

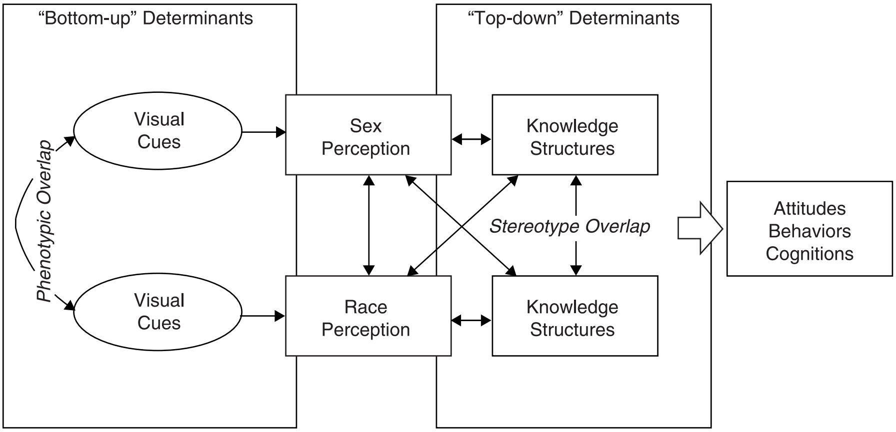
Unlike the tightly controlled laboratory settings used as staging grounds to test theories with rigorously controlled experimentation, the social objects of our perception tend *not* to fall only into one social category. Instead, people fall into multiple social categories simultaneously. Research investigating the effects of social categories on meaningful interpersonal outcomes has failed to appreciate the complexities that the intersection of social categories (or intersectionality) introduces to the task of perceiving others.

Historically, social psychologists have focused their empirical work on the weighty consequences of perceiving social categories (Allport, 1954; Brewer, 1988; Fiske & Neuberg, 1990) and the inevitability versus malleability of encoding social categories (Blair, 2002; Macrae & Bodenhausen, 2000). Because of their focus, social categorization was taken as a given – a starting point after which interpersonal phenomena of interest occurred (e.g., stereotyping and interpersonal attraction). Little attention was paid to the determinants and processes leading up to social categorization, although they were acknowledged to be determined by factors such as available cues, motivations, and cognitive processes. The focus of this research was to explicate the *consequences* of social categorization, and therefore presumed a feedforward model of social categorization (see Figure 11.3a). The simple message from this line of work was that categorization had interpersonal consequences, and the research that fit into this framework was straightforward. Social categories were manipulated along one dimension, but remained invariant along other social category dimensions; stimuli depicted the category of interest for the particular study (e.g., sex), and held all other social categories constant (e.g., race, emotion state). Moreover, the factors that contributed to the social categorization in the first place were not centrally important to this research. This approach afforded precision in documenting the downstream consequences of social categorization at the cost of breadth of understanding. Consequently, our understanding of social perception remains incomplete.

One reason that the extant research yields an incomplete picture of social perception is its mistaken focus on dominance. As noted previously, the vast bulk of empirical research has eliminated intersectionality of social categories entirely through experimental manipulation. The few exceptions to this general rule reveal



a. Feed-Forward Model of Social Categorization



b. Intersectional Model of Contextualized Social Categorization

FIGURE 11.3 Models of social categorization: (a) The prevailing feedforward model of social perception that emphasizes categorization as a discrete representation of a dominant social category, and subsequently examines the downstream consequences thereof. (b) A simplified version of our proposed intersectional model of social perception in which visual cues to social categories continuously inform category activations through bottom-up visual perception processes and in which existing knowledge structures (i.e., stereotypes) modulate the perception and interpretation of visual cues to category membership via top-town processes.

a theoretical assumption underlying theories of social perception: that when multiple social categories apply to an individual (e.g., one's sex, race, and age), only one category domain (e.g., sex category membership) will come to dominate social perception. In one study that highlights this presumption, for example, participants were primed with either the Female sex category, the Asian race category, or no category at all (Macrae, Bodenhausen, & Milne, 1995). After watching a short video clip depicting an Asian woman, a lexical decision task assessed the activation of the applicable sex and race categories. Those participants primed with the target's sex showed activation of Female (i.e., faster latencies, relative to control) and inhibition of Asian (i.e., slower latencies, relative to control); those primed with the target's race showed activation of Asian category, and inhibition of Female category. These authors argued that one category therefore dominates perception, and all other categorical possibilities are removed from working memory through inhibition.

This implicit assumption is widespread, and which particular category comes to dominate perception is theorized to be the product of two types of motivation. At times, motivation to construe others in terms of a single category serves general processing objectives – to ease the task of perceiving others. This perspective stems from theoretical perspectives that presume observers to be motivated for cognitive efficiency (originally articulated by Allport, 1954). Thus, viewing others as falling into one dominant social category makes the job of the perceiver considerably easier. Evidence for this type of motivational impact is implied in several studies, but more generally, has been a driving force to understand which social categories are perceived in an obligatory fashion. Overall, three social categories seem to fit – sex, race, and age – and which of these comes to dominate perception varies with social composition.

At other times, motivation to construe others in terms of a single category serves more individualized or higher-level goals (e.g., to maintain one's own positive self regard). Social categories vary in the degree of status associated with them, and observers can use this to their advantage. When individuals have received unflattering feedback, for example, their categorization of others tends to highlight low-status aspects of the target's identity (Sinclair & Kunda, 1999). This pattern was theorized to originate in the motivated inhibition of a desirable stereotype and activation of an undesirable stereotype associated with the target's identity (Sinclair & Kunda, 1999).

Another reason that the extant research yields an incomplete picture of social perception is its presumption that social categorization involves either one or several discrete social category representations purely instantiated in working memory. Although few studies have directly examined the *process* by which social categorization occurs, much of the research that has looked at this implies that categorization evokes an "all or nothing" proposition (cf. Locke, Macrae, & Eaton, 2005). This particular perspective may have emerged because social psychological research has, by and large, made the assumption that the human brain represents social categories just as a digital computer might: as discrete symbols that are either on or off, active or inactive. This is consistent with classical notions of the mind as a computational *physical symbol system* (Newell, 1980; Pylyshyn, 1984), and discrete feedforward representational accounts of cognition (e.g., Fodor, 1983). Based on the misled assumption of discreteness in social categorization, the assumption of dominance described above comes naturally. If social categories were represented discretely, then one social category *must* dominate perception. All other possibilities must be defeated.

While appealing because it is elegant and intuitive, such work ignores decades of research in cognitive science and neurophysiology, carrying a clear message: The human brain does not work that way! That is, the brain is best described not as a computer operating on discrete symbols cycling on and off in idealized states, but rather as a complex biological system using collaborative neurons working in real-time (e.g., Spivey, 2007; Spivey & Dale, 2004, 2005). Two consequences of this research are that mental representations are seen as probabilistic (a collaboration of neurons trying to stabilize) rather than pure (an idealized computer-like symbol), and that multiple representations may be simultaneously and partially active in working memory rather than proceeding one at a time in discrete form. Although now well documented in certain camps of cognitive science investigating lexical representations, the possibility that s*ocial category* activations may be simultaneously or partially active in working memory is largely incompatible with the theoretical positions informing the vast bulk of social psychological research. Consequently, this research continues to presume that only one social category may be active at any given moment in time. It is thus not surprising that the mechanism by which one category alternative comes to dominate social perception has received little empirical attention.

The presumption that social categorization culminates in a discrete representation of primarily one category has been sufficient to address many specific questions, but it is insufficient to understand the complexities of social perception, more generally. We propose that social perceivers are faced with a complex perceptual task that is prone to be influenced heavily by context. Social targets in the lab fit nicely within narrowly defined category boundaries; social targets "in the wild" do not. They vary in the conjunction of social category membership (sex, race, age, emotion state, and occupation, to name a few) and in the degree to which visual cues reveal these categories. During person construal, such factors are not perceived independently, but rather simultaneously, each contextualized by the presence of other orthogonal categories and cues. Put simply, social categories and the cues that convey them *are* social context. As such, the perception of one category or cue will inevitably affect the perception of another. This has implications for both the perceptual outcome and the processes that give rise to social percepts.

Specifically, characterizing social categories and the cues that convey them as context challenges the assumption that observers represent others as discrete representations of a dominant social category. Instead, we propose that person construal is a fluid and dynamic process by which probabilistic – and never pure – representations of others affect one another throughout social perception. One simplified model of this process is depicted in Figure 11.3b. Rather than a simple feedforward process that focuses on the implications of social categorization, an intersectional model of social categorization recognizes that the perception of social categories is heavily negotiated by context afforded by other aspects of person construal. Notably, because cues that support categorization are likely to vary in their diagnosticity, social categorization may be best represented as a dynamic process – continually incorporating the available evidence, not achieving discrete representations of dominant categories, but rather stabilizing on working representations across a probabilistic journey of gradual perceptual uptake (see Freeman, Ambady, Rule, & Johnson, 2008; Spivey & Dale, 2004). Moreover, the perception of one category may recruit knowledge structures about an orthogonal social category because of the similarity of stereotype content – and this may affect perception of another social category. This possibility implies a top-down moderation of perceptual processes that can alter the perceptual endpoint. Evidence for our contention that social categories and the cues that convey them serve as context for perception comes from two programs of work – one focused on temporal dynamics of person construal, the other focused on the intersectionality of social categories.

## SOCIAL CONTEXT FROM PERCEIVED CUES: THE TEMPORAL DYNAMICS OF SOCIAL CATEGORIZATION

Many experimental paradigms within social psychology follow some variation of a basic method: (a) a face is shown on a computer screen; (b) it is categorized by race, sex, age, or emotion (depending on the study); and (c) the experimenter measures the consequences. To be sure, important visual information is being processed between the onset of the image and the categorization that takes place, even though this occurs on the order of milliseconds. Yet the nature of this process has remained obscure and generally of little interest to social psychologists. This is unfortunate.

Two considerations make understanding the process of social categorization critically important. First, our theories have used an outdated model. We now understand the human brain as composed of collaborative neuronal populations continuously working in real-time, rather than as a digital computer working in discrete stages (although some continue to oppose this position; Dietrich & Markman, 2003). Second, from a Gibsonian perspective, the social world is composed of ecologically valid targets that provide continuous stimulation – rather than discrete inputs like flashes on the computer screen familiar to the social psychology lab. Taken together, the importance of understanding social categorization as a continuous rather than discrete process becomes critical.

Part of the problem is that prevailing social psychological accounts of the person construal process, presuming discreteness, do not fit with actual neurophysiological evidence for the way the human brain continuously – and not discretely – takes up perceptual information across person construal. In a classic study, Rolls and Tovee (1995) recorded the activity of monkey neurons in STS and inferotemporal cortex while monkeys were presented with faces. Not surprisingly, many of these neurons were more selective to one given face or another. For instance, one population of neurons coded the recognition of one face and a separate population coded the recognition of a different face. More remarkable, however, is how these populations achieved their firing rates over time. In just the first 70 ms after catching sight of a face, the corresponding neuronal population for that face already reached about 50% of the full activity that it would exhibit several hundred milliseconds later at conscious face recognition. Thus, the remaining 50% of the perceptual information was continuously gathered and encoded across several hundred milliseconds to gradually – and not discretely – stabilize on the recognition of another's face.

Such evidence highlights the person construal process as a dynamic and fluid process wherein neuronal populations continuously incorporate the perceptual information from the world and gradually stabilize on particular working representations of others. This is quite a different story than that of prevailing social psychological accounts, which presume that all perceptual information is immediately available the moment a face suddenly appears (an experience only happening in the lab). According to these accounts, several hundred milliseconds after the onset of a face stimulus, a discrete representation of a social category "pops" into consciousness – and then out of consciousness shortly thereafter, once a categorical judgment has been made, as if processing of the target has finalized with a keyboard press and working representations immediately vanish from working memory.

This prevailing account of social categorization is sharply at odds with our proposal that social categorization involves multiple probabilistic representations, which are simultaneously and partially active across construal and gradually settle onto ultimate categorical judgments. We have recently provided evidence for this proposal. In one study, we (Freeman et al., 2008) presented participants with computer-generated male and female faces at the bottom-center of a computer screen. Participants categorized the sex of these faces by mouse-clicking a "Male" or "Female" label in the top left and right corners of the screen. Critical trials involved atypical male and female targets whose sex was generated at a level systematically closer to the opposite sex. For instance, a typical target would be a random face generated at 100% Male. This face was then morphed to depict 75% Male and 25% Female features, producing an atypical target. Though participants reliably chose the correct sex category, an analysis of participants' computer mouse trajectories as they did so was revealing. Relative to the more typical trials, when categorizing atypical targets, participants' hand movements were continuously more attracted toward the opposite sex category, which appeared on the opposite side of the computer screen (see Figure 11.4).

This continuous spatial attraction in hand movements indicates that across the course of social categorization, participants were continuously integrating input from multiple perceptual cues (i.e., physical evidence of both Male and Female category alternatives) that fluidly stabilized into a single confident interpretation of the face's sex category membership. This pattern of results was also obtained for race categorization (Freeman, Pauker, Applebaum, & Ambady, 2010). Prevailing accounts of social categorization, grounded in the assumption of discreteness, could neither predict nor explain this pattern of results. Yet the pattern is indeed informative. We argue that person construal is a dynamic process in which a perceiver's interpretation of the face reflects the continuous update of multiple probabilistic representations, guided by the gradual accumulation of perceptual evidence. In a later study, this was also extended from social category activation to the triggering of category-associated stereotype knowledge (e.g., male → *aggressive*, female → *caring*), showing how dynamic competition during social categorization continuously cascades into the partial and parallel activation of associated stereotypes (Freeman & Ambady, 2009).

This kind of dynamic social perception is precisely what person perceivers would require if social context information indeed interacts with lower level perceptual information to guide person construal, as we have argued throughout this chapter. Indeed, such a premise is supported by a wealth of neurophysiological evidence for the existence of recurrent feedback supplied by many projections from higher-level neural subsystems back down to lower-level visual cortex (Douglas,

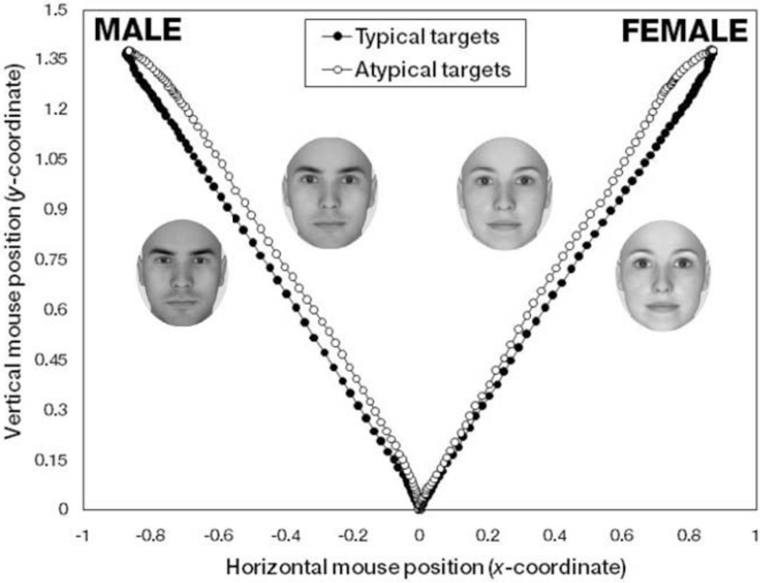


FIGURE 11.4 Dynamic social perception (adapted from Freeman et al., 2008). Participants are presented with computer-generated male and female faces at the bottom-center of the screen. Faces are categorized by sex by moving the mouse from the bottom-center to either the Male or Female label while mouse movements were recorded. Mean mouse trajectories are plotted. Male targets were either typical, generated at 100% Male (A), or more atypical, generated at 75% Male and 25% Female (B). Mean trajectory for atypical male targets (white circles, left side) exhibits a statistically reliable continuous attraction towards the "Female" label, relative to mean trajectory for typical male targets (black circles, left side). Female targets were either typical, generated at 100% Female (C), or more atypical, generated at 75% Female and 25% Male (D). Mean trajectory for atypical female targets (white circles, right side) exhibits a statistically reliable continuous attraction towards the "Male" label, relative to mean trajectory for typical female targets (black circles, right side).

Koch, Mahowald, Martin, & Suarez, 1995; Gilbert, 1998; Gilbert, Ito, Kapadia, & Westheimer, 2000). Such evidence is cited to explain numerous top-down context effects in non-social domains of visual perception, such as the McGurk effect (McGurk & MacDonald, 1976).

In sum, investigations examining the temporal dynamics (Freeman et al., 2008; Freeman & Ambady, 2009; Freeman et al., 2020) and neurophysiological underpinnings of social categorization (reviewed briefly above) point to a dynamic person perception process. In contrast to prevailing accounts that pivot around dominance and discreteness, our proposal characterizes person construal as dynamic and continuous, involving probabilistic representation of social categories. We call this perspective a *dynamic continuity account* of person construal (Freeman et al., 2008).

## SOCIAL CONTEXT FROM PERCEIVED CATEGORIES: ON THE COMBINATORIAL NATURE OF CATEGORIZATION

In many ways, the dynamic continuity account of person construal focuses on how cues continuously and dynamically affect the representation of others. In addition to varying in the degree to which visual cues dynamically compel a particular categorization *within* a domain, targets of social perception also vary *across* social category domains. Social targets of visual perception are not only men or women, but also young or old; black, white, Asian, etc. This reality has scarcely been incorporated into prior research even though observers are likely to attend to the combination of these dimensions as person construal unfolds. We propose that the perceptions of multiple category domains, though orthogonal in reality, are likely to be perceived interdependently. That is, we propose that the perception of one category domain will modulate the perception of other social category domains. This is likely to occur for at least two reasons.

To be sure, the perception of one social category may affect the perception of another social category due to phenotypic overlap in the visual cues associated with each domain. For example, physical cues to sex category are conflated with the muscular configuration of emotion state and are tethered to perceptions of dominance and affiliation (Hess, Adams, & Kleck, 2004, 2005). Because the morphological cues to two distinct domains of social perception are conflated, the perception of one domain biases perception of the other domain. In many ways, this type of effect can be considered a *bottom-up* effect of intersectionality on person construal.

The perception of one social category may also affect the perception of another social category because prior knowledge structures bias perception. Although it is undeniably the case that social categories are orthogonal in reality (e.g., sex and race do not covary), the notion that they are also orthogonal psychologically is less clear. Indeed, there is good reason to predict that some intersecting social categories will be psychologically conflated. It is this aspect of intersectionality that we will now turn to.

Visually perceiving cues that are diagnostic of a social category is sufficient to activate knowledge structures that are associated with the category (Bargh, Chen, & Burrows, 1996; Mason, Cloutier, & Macrae, 2006). Consequently, perceiving visual cues for the Female category is likely to evoke the activation of traits such as shy, family-oriented, and soft-spoken (Bem, 1974; Devine & Elliot, 1995; Karlins, Coffman, & Walters, 1969; Spence, Helmreich, & Strapp, 1974). Similarly, perceiving visual cues for the Male category is likely to induce activation of traits such as aggressive, dominant, athletic, and competitive (Bem, 1974; Devine & Elliot, 1995; Spence et al., 1974). It is therefore unsurprising that these knowledge structures, once summoned, influence impression formation and interpersonal interactions.

Yet we propose that the impact of these activated knowledge structures may extend to other aspects of social perception as well, even affecting the perception of other social categories. One need only look to the stereotype content of intersecting social categories to see why this might be the case. The sex-role stereotypes listed above, for example, apply not merely to sex categories, but also to race categories. That is, the traits shy, family-oriented, and soft-spoken apply not only to the Female category, but also to the Asian category (Bem, 1974; Devine & Elliot, 1995; Ho & Jackson, 2001; Karlins et al., 1969; Spence et al., 1974). Similarly, the traits aggressive, dominant, athletic, and competitive apply not only to the Male category, but also to the Black category. While it is certainly not the case that stereotype content shows a wholesale overlap between these social categories, it is evidence that a substantial degree of overlap exists. And this has broad implications for other aspects of perception.

Because of overlapping stereotype content, the activation of knowledge structures from the perception of diagnostic visual cues may also be sufficient to activate another social category. Thus, perceiving one social category may contextualize the perception of another social category via this top-down route. Thus perceiving the category Black will activate the associated stereotype and, because of the overlapping content, also activate the category Male. Similarly, perceiving the category Asian will activate stereotype content that will in turn activate the category Female. This has implications for the efficiency of social categorization.

Together with our colleagues, we have tested these ideas in a series of studies designed to assess how intersecting social categories affect perception (Johnson, Freeman, & Pauker, 2010). We predicted that the efficiency of sex categorization would vary as a function of race category membership because of the degree of compatibility between the stereotypes evoked. Specifically, we predicted that sex categorization would be facilitated when compatibility between stereotypes is high (e.g., Black Men or Asian Women), but impaired when compatibility between stereotypes is low (e.g., Black Women or Asian Men).

We tested these predictions using several methods. For each study we generated a stimulus set that varied continuously across three race categories: Black to White to Asian. In one study these stimuli were designed to be gender-ambiguous. Participants provided sex category judgments for these stimuli. We found a striking dependency between the apparent race category of the stimuli and observers' judgments of sex category. Black faces were more likely to be judged to be men; Asian faces were more likely to be judged to be women. Thus, a target's race category that was irrelevant to the judgment task nevertheless biased perceptions of sex category.

In other studies, we exploited the mouse-tracking method described previously to determine the degree of interference that the irrelevant race category exerts on sex categorization (see Figure 11.5). In these studies, both male and female stimuli varied continuously in apparent race category. We predicted, and found, that faces for which intersecting social categories shared stereotype overlap (i.e., Black Men and Asian Women) elicited mouse trajectories that were relatively direct. Faces for which stereotype overlap was low (e.g., Asian Men and Black Women), in contrast, did not. On these trials, mouse trajectories revealed a significant deviation (toward the interfering social category on the opposite side of the computer screen) from an idealized linear trajectory. Again, these effects obtained in spite of the fact that race category was irrelevant for the sex categorization at hand.

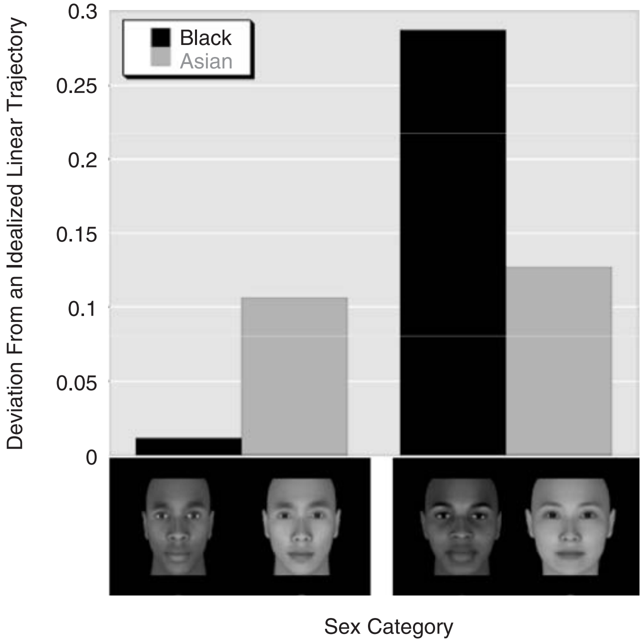


FIGURE 11.5 Mouse trajectory deviation for targets with intersecting identities. This depicts the deviation from an idealized linear trajectory for sex category judgments of faces that varied in both sex and race (adapted from Johnson et al., 2010). Combinations for which stereotype overlap was high (e.g., Black Men and Asian Women) compelled more direct trajectories than combinations for which stereotype overlap was low (e.g., Black Women and Asian Men).

We interpreted these and other effects as evidence for top-down mediation of sex categorization due to overlapping stereotypes. Indeed, in a final study, we found more direct evidence for our interpretation. We repeated the mouse-tracking study, but also assessed the degree of stereotype overlap between the categories Black and Male and the categories Asian and Female using a modified Implicit Associations Test. Among participants for whom these associations were strong, mouse trajectories and reaction times for sex category judgments were perturbed when categorizing targets with mismatched stereotypes (i.e., Black Women and Asian Men). Among participants for whom these associations were low, such measures were less heavily impacted.

## CONCLUSIONS

We have presented evidence that challenges prevailing notions of social categorization. We characterized social categories and the cues that convey them to be social context that continuously influences the process and product of social categorization. The evidence that we have presented suggests that social perception does not involve a discrete representation of a dominant social category, but rather is a dynamic and fluid process, involving multiple probabilistic representations both within and between category domains, and is heavily influenced by both top-down and bottom-up perceptual mechanisms.

Our theoretical approach to social perception represents a clear shift toward understanding the mind as a dynamic biological system and away from analogies that liken it to a computing device. In doing so, we characterize person construal as a process in which populations of neurons gradually stabilize over time (e.g., Spivey, 2007). This perspective emphasizes the interaction between top-down and bottom-up processes that fluidly integrate over fractions of a second to yield our everyday impressions of others. An integrated mind of this sort, operating interactively and continuously over time, is essential for the demands of social perception (Freeman & Ambady, 2009; Freeman et al., 2008). In social perception in day-to-day life life, the perception of others' emotions, intentions, and other social characteristics must be continuously updated from a stream of sensory information that is in a constant state of flux. By adopting this approach, we join a growing number of cognitive scientists (e.g., Spivey, 2007; Spivey & Dale, 2004, 2006) and vision scientists (e.g., Song & Nakayama, 2008), among others, in characterizing human perception as a highly integrative and dynamic system that collaborates with both cognition and action.

As our opening quote makes clear, J. J. Gibson recognized other people to be among the most important stimuli to be visually perceived in the environment. While most of our social psychological colleagues would warmly embrace this particular premise, we hope that this chapter, and the work reviewed within it, begins to challenge the long-held and idealized models of person construal, replacing them with an understanding of the dynamic and highly integrated nature of social perception. Indeed, Gibson recognized perception, in general, to be a dynamic process, stating: "The theory of affordances rescues us from the philosophical muddle of assuming fixed classes of objects, each defined by its common features." Similarly, we believe that the prospect of a Gibsonian understanding of the dynamic nature of person construal will rescue us from the muddle of ill-specified models, permitting us to see beyond the theoretical and empirical constraints imposed by dominance and discreteness.

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# 12

# Emotional High: Emotion and the Perception of Spatial Layout

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Traditionally, perceptual psychologists have argued that the visual system perceives the spatial layout of the environment (e.g., how far, high or big objects are) by simply representing the geometrical configuration of that environment. This representation of the environment is thought to be modular and independent of concurrent emotional and cognitive processes. However, recent research suggests that physiological aspects of the observer may influence the perception of spatial layout. For instance, people view hills as steeper after a long run and distances as farther if they are carrying a heavy load (Proffitt, Bhalla, Gossweiler, & Midgett, 1995; Proffitt, Stefanucci, Banton & Epstein, 2003). Research has also shown that manipulations of the ability of observers to perform a task can influence judgments of the size of objects and the distance to those objects (Witt & Proffitt, 2005). These studies provide converging evidence that the *state* of the observer influences the perception of spatial layout. These manipulations have been primarily physical or physiological in nature, but researchers are now beginning to wonder whether alternate states of observers, especially emotions, might influence the perception of the environment as well. Intuitively, it seems reasonable that participants in a fearful or aroused state might experience an altered reality. This chapter will discuss evidence that supports the claim that emotions can alter perception. It reviews various types of emotional manipulations and their effects on the perception of slant, distance, and height.

## BACKGROUND: THE PROBLEM OF PERCEPTION

How do we perceive the world around us? How do we judge whether something is too far to reach or too high to jump from? Questions related to how we perceive the layout of our environment are some of the oldest questions in perceptual psychology and psychology in general. In his early works on vision, Berkeley (1709/1975) argued that the perception of distance is difficult (if not impossible) because the projection of a point of light into the eye contains no information about distance. Accordingly, he proposed that in order to discover the distances to objects, visual processes must be combined and associated with touch information over time and experience. The study of perception of spatial layout has progressed from the philosophical inclinations of Berkeley, of course, but Berkeley's question of how the visual system recovers a three-dimensional world from a two-dimensional image on the retina has endured.

The eye's retina is a two-dimensional surface onto which light is projected from the world. This light specifies the location of objects in a three-dimensional world; however, as these dimensions are condensed on the retina, information needed to perfectly locate and estimate three dimensions in the environment is lost in the conversion from three to two dimensions. The information was three-dimensional in the real world, but it is flattened to two dimensions when projected onto the retina, so this creates problems for perceiving the distance that different sized objects are from the retina or the orientation of these objects in space, among other information in the scene. And yet we still manage to navigate the world effectively and are able to reach out and pick up objects, so the information that is needed to interpret three dimensions must be present or recovered by the visual system somehow. Many approaches have been posited as to how this problem is solved. Some researchers argue that the visual system represents the geometry of the world by combining the stimuli (light) from the environment with assumptions, biases, and knowledge inherent to the observer (called inferential approaches to perception; see Gregory, 1978; Ittelson, 1968; Rock, 1983). However, the perceptual psychologist J. J. Gibson stated that no outside information is needed for the visual system to recover three dimensions from the light. In essence, he claimed that the problem was not a problem at all for the perceiver when he or she takes into account the resources and information available for discovering layout when allowed to move (called the ecological approach to perception; see Gibson, 1979). Indeed, the bulk of research in perceptual psychology has shown that information from moving observers (optic flow), differing information from the position of the two eyes in the head (binocular disparity), and ocular–motor adjustments of the two eyes (convergence, accommodation) can reveal the distances and sizes of objects in the environment without any other information needed.

A whole chapter could be written just on these two proposed solutions (inferential vs. ecological approaches to perception) for the problem of perceiving a three-dimensional environment (see Proffitt, 1999). In all of the approaches, the important thing to note is that vision is considered to be a modular process (i.e., one in which the information used for vision is specific to vision and the process by which that information is understood by the system is carried out in isolation from other concurrent processes in the brain) that is mostly insulated from other higher-level processes such as memory, attention, reasoning, and emotions. In this chapter, I present evidence that suggests that vision is affected by concurrent, high-level processes. Specifically, the data indicate that bodily states can alter space perception when manipulated in myriad ways (physiological potential, intention, and emotion). These states affect measures of many different aspects of the three-dimensional layout of the environment (slant, distance, height, and size). In essence, people who are in a different state may see the world through a "distorted lens," which provides a more adaptive and functional way of viewing the world. The visual system, needing to solve the problem of perception and interpret the world for action, uses information from the body to estimate and scale the layout of the environment. In this chapter, the evidence will suggest that humans use physiological, intentional, and emotional information to this end.

## NORMATIVE PERCEPTION OF SPACE

Observers naturally see the environment in a biased way: Hills and heights tend to be overestimated, distances tend to be underestimated, and the size of objects can be overestimated or underestimated depending on the experimental setting. An understanding of the biases associated with perceiving different aspects of the environment is necessary so that the influences on these biases, such as physiological, intentional, or emotional states, may be better described.

### *Geographical Slant*

Proffitt et al. (1995) found that, on average, people grossly overestimate the slant of hills. For example, a 10° hill is typically judged to be 30° with conscious estimates of visual awareness. Proffitt et al. asked participants to stand at the bottom or at the top of hills with varying degrees of incline (2–34°) and estimate the slant of the hill in three ways: verbally, visually, and haptically. Verbal judgments consisted of a participant telling the experimenter how steep the hill was in degrees. Visual judgments were made using a metal disk that had an adjustable portion representing the cross-section of the hill. Participants were told to adjust the cross-section until it matched the inclination of the hill they viewed. Haptic judgments were done on a tilt palmboard. Participants placed their dominant hand on the palmboard, which was adjusted to their waist height. They were asked to tilt the palmboard (while looking at the hill, not their hand) to be the same inclination as that of the hill (see Figure 12.1).

The data established a normative overestimation of slant across all inclines with the measures of explicit awareness (Proffitt et al., 1995). The measures of explicit awareness were the verbal reports and the visually matched estimates described above. The authors believe that these measures represent conscious estimates of slant because they are performed explicitly and participants are fully aware of their responses. However, using the palmboard is a visually guided action or visuomotor process that relies on an unconscious visual system responsible for spatially localizing objects and guiding actions associated with them. This distinction between conscious and unconscious visual systems was originally proposed by Ungerleider and Mishkin (1982; adapted from Schneider, 1969), and was further supported by evidence from Milner and Goodale (1995). With respect to geographical slant, one can think of using a palmboard as analogous to taking a step

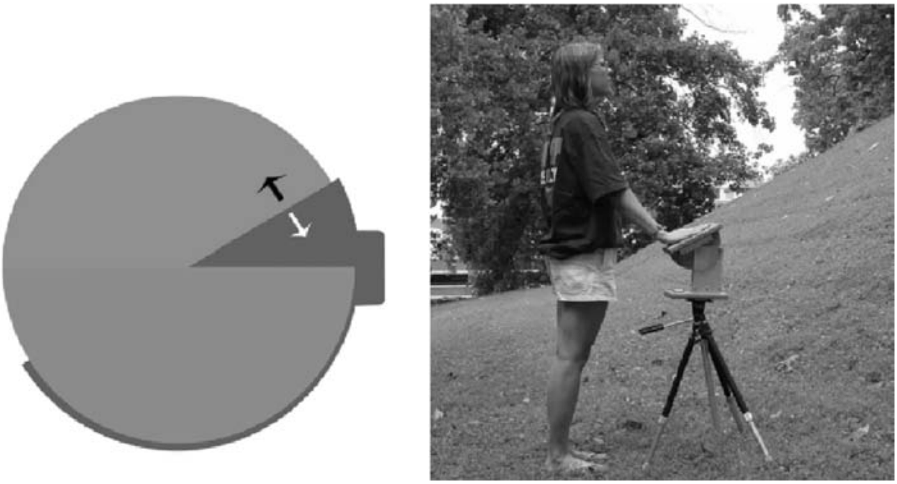

FIGURE 12.1 On the left is a depiction of the disk used for the visual matching task. Participants were asked to make the dark green section (color not shown here) to be equal to the slant of the hill. On the right is a picture of the haptic palmboard. Participants were told to adjust the palmboard until it was parallel to the incline of the hill (without looking at their hand).

onto the hill. It is obvious that one would not want to overestimate the slant of a hill because such an error might lead to a misstep or fall.

It is important to note that overestimation of hill slant is useful because it makes observers more sensitive to the hill slants (those which are smaller) on which they normally act (see Proffitt, 2006; Proffitt et al., 1995). The hills in our everyday environments are fairly shallow, considering that a hill can be any degree of inclination between 0° and 90°. For example, no road can be steeper than 9°, by law, in the state of Virginia. A 35° hill is too steep to walk down; the observer must break into a run or slide down. Therefore, an enhanced sensitivity to a smaller range of hills would be more advantageous for observers to possess than a general ability to discriminate hills between 0° and 90°. Proffitt (2006a) suggests that increased sensitivity to small hills is particularly adaptive because it allows the observer to better discriminate a 4° hill from a 5° hill (ones with which they regularly interact) rather than a 30° hill from a 31° hill (with which they would not interact as regularly).

### *Distance*

In contrast to slant estimates, distance estimates are fairly accurate up to 4 m. As distance increases, however, estimates are increasingly underestimated, with a typical observer reporting approximately 9 m for a 10-m distance (see Amorim, Loomis, & Fukusima, 1998; Cutting & Vishton, 1995; Loomis, Da Silva, Fujita, & Fukusima, 1992; Norman, Todd, Perotti, & Tittle, 1996). However, this bias in distance perception is only exhibited in some of the measures used to estimate distance and when the distance is egocentric (the observer is standing at one endpoint of the distance).

A typical method used to obtain egocentric estimates of perceived distance involves asking observers to represent or replicate the extent they are viewing in another direction (termed visual matching). Observers view the extent and then position an experimenter or another object to be the same distance from them as the viewed extent. In other words, observers might be asked to make an "L" in which the two legs of the L are the same extent. When asked to perform this task, observers exhibit the typical underestimation described above (Loomis et al., 1992).

Observers are sometimes also asked just to verbally report the extent, similar to the verbal reports described in the geographical slant studies. When asked to judge how far something looks to be from them in feet and inches or in meters, observers often underestimate the extent, and this underestimation is especially pronounced in distances greater than 4 m (Proffitt et al., 2003; Witt, Proffitt, & Epstein, 2004; Stefanucci, Proffitt, Banton, & Epstein, 2005; also see Philbeck & Loomis, 1997).

In contrast, other measures of distance do not seem to produce the large underestimations discussed previously (for a comparison of measures see Andre & Rogers, 2006). For example, "blindwalking" (walking to a previously viewed target without vision) is a visually directed or visually guided action that has been used in many studies as a measure of distance perception (Corlett, Patla, & Williams, 1985; Elliott, 1987; Loomis et al., 1992; Rieser, Ashmead, Talor, & Youngquist, 1990; Steenhuis & Goodale, 1988; Thomson, 1983). In a representative experiment, observers view a target on the ground and then close their eyes (or are blindfolded) and are asked walk to the remembered location of the target. Because they are without vision, they must rely on proprioceptive and vestibular cues to update their body movement and position as they move through space in order to decide when to stop walking. Observers are very accurate at reproducing distances with this task, even when distances as large as 20 m are measured.

## *Size*

The perception of size in full-cue conditions is fairly accurate, though certain measures and situations can distort estimates of perceived size. In particular, most changes in estimates of perceived size occur as the distance to the judged object increases. Similar to distance estimation, observers are often asked to simply give verbal reports of the size of objects (either their width or height). The observers are allowed to use any stored metric (feet or meters or inches, etc.). The findings here have shown that their estimates are accurate at close distances (Gilinsky, 1955). Observers have also been asked to replicate the size of a viewed object by adjusting another object to be the same size (e.g., a visual matching task). The matching object is usually close to the participant and the target object (the one being matched) is usually at a farther distance. Findings showed that observers tended to overestimate the size of farther objects even when viewing them in full-cue outdoor environments (Gilinsky, 1951; Leibowitz & Harvey, 1967, 1969). However, Haber and Levin (2001) found that estimates of the perceived size of objects were very accurate when participants took knowledge of the prototypic size of the object into account, as well as how much variation they had experienced with the prototypic size of the object in the past.

### *Height*

Height studies have typically asked the observer to estimate the height of an object in one of two locations, either standing away from the height (exocentric) or standing directly above or below the height (egocentric). Both viewpoints have demonstrated that heights (vertical extents) are generally overestimated using a variety of measures.

Yang, Dixon, and Proffitt (1999) asked participants to exocentrically (viewing the height from a perspective that was not directly above or below the height) estimate the height of various objects in the real world, with heights ranging from a little over 2 m to a little under 14 m. A visual matching measure was used (similar to that described in the distance experiments above); however, participants positioned a pole to be equidistant in the fronto-parallel plane to the height of the object they viewed (again, the matching task produced something akin to an L for which participants were supposed to make the two legs equidistant). The observer stood at a distance from the height, and an experimenter held the pole and walked out from the base of the height laterally until the observer instructed them to stop. The distance on the ground between the experimenter and the object represented the height of the object.

The larger the object, the more observers overestimated the height of the object relative to the horizontal extent, even though the visual angle to all of the objects across participants was held constant. Proportional overestimation of the vertical was calculated by dividing the actual height of the target by the produced horizontal extent. A proportional overestimation of exactly 1.0 indicated a perfect estimate of the height of the object with the horizontal extent. For the objects used in this experiment (given in order of increasing physical size with their proportion overestimation), larger objects were overestimated more than smaller objects: door, 0.99; light pole, 1.06; edge of chemistry building, 1.13; edge of psychology building, 1.18. The findings suggest that heights are overestimated on the ground, but only when they are relatively large.

Oddly, there has been very little research on people's egocentric perceptions of height, that is the perception of vertical extents, as viewed from a height looking down or the ground looking up (see Figure 12.2). Sinai, Ooi, and He (1998) briefly reported a study showing that participants who stood at the top of a 6-foot vertical drop overestimated the distance to the ground with visual matching and blindwalking measures of perceived distance to the ground. However, they attributed the results to a misperception of eyeheight and did not include a comparison of viewing the height from the top to viewing the height from the bottom (a potential baseline measure). Also, viewing the height from the top would,

FIGURE 12.2 Participants viewing a height egocentrically from above (left) and from below (right).

presumably, evoke fear or anxiety more than when viewing from the bottom. Therefore, a better understanding of how people perceive heights from the top would be necessary to discuss how fear, arousal, or anxiety influences that perception.

More recent studies have compared height perception when viewing from the top and from below. Jackson and Cormack (2007) found that people who were standing at the top of a height overestimated the height more with a visual matching task than people standing at the bottom of the height. Stefanucci and Proffitt (2009) replicated this finding and extended it to include a blindwalking measure of height perception and estimates of size perception from above and below a height. The visual matching tasks in both studies involved positioning an experimenter along a balcony to be the same distance from the observer as the observer (or the railing in front of the observer) was from the ground. In both sets of studies, and with all measures, heights were overestimated more when viewed from above. The magnitude of overestimation varied across measures, but was typically around 60% when viewed from above and 30% when viewed from below. In other words, people who viewed a 25-foot height estimated it to be 32 feet from below and 40 feet from above. Participants even overestimated the height from above when performing a blindwalking task. This overestimation is especially interesting because previous studies on horizontal distance perception have never found an overestimation of distance with blindwalking measures, only underestimations.

This finding, along with the disparity in overestimation when judging the height from the top as compared to the bottom, suggests that another factor is influencing observers' estimates of height as compared to horizontal distances. We believe that this factor is likely non-optical and related to the emotional state of the observer. This hypothesis is born out of years of experiments showing that other bodily states could influence the perception of spatial layout. I turn now to that body of research.

## EMBODIED PERCEPTION

Work over the past 15 years has begun to suggest that vision may not be as modular or insulated from concurrent processes or bodily states as we once thought. An embodied approach to perception has developed which claims that states of the body can influence perception. Initially, the embodied perception approach focused on the action capabilities of the observer and the influence of those capabilities on perception. I will describe that research first and then turn to the work that motivated the question of whether emotional states also influence perception.

It is important to note that the predecessor to the embodied approach to perception was the New Look in Perception, a movement that began in the 1950s. Researchers of the New Look asked theoretical questions that were very similar to the questions of the embodied perception approach (see Bruner & Goodman, 1947 for the first experiments conducted in the movement). For instance, Bruner and Goodman showed that financially poor children estimated coins to be larger than cardboard circles of the same size. These children also estimated the coins to be larger than non-poor or better-off children. The movement postulated that value and need could result in differences in size perception. However, further studies on these effects failed to replicate the results of the previous studies, and instead the results were attributed to methodological inconsistencies (Tajfel, 1957). The New Look was mostly discredited, but the findings in this chapter resonate with its approach.

## PHYSIOLOGICAL POTENTIAL INFLUENCES SPACE PERCEPTION

The first study to examine the effect of physiological potential on the perception of spatial layout found that tired people overestimate the slant of hills more than the rested (Proffitt et al., 1995). The authors observed that the hills in a bike race always felt harder to ascend and looked much steeper in the last leg of the race, even if they were the same steepness as earlier hills in the race. This anecdotal evidence was experimentally tested on observers who completed a long run during the course of an experiment. The runners were asked to judge the steepness of a hill before their run and then to judge the steepness of a different hill after their run. The overestimation of slant was greater after the run, even when both hills had the same incline. When people were tired from a run, they saw steeper hills (see Figure 12.3).

A series of studies conducted by Mukul Bhalla and Dennis Proffitt replicated the finding that physical fatigue influences slant perception and extended the findings to other domains of physical capabilities (Bhalla & Proffitt, 1999). First, they showed that people who wore a heavy backpack (carrying about one-fifth of their body weight) estimated hills to be steeper than those who did not wear a pack. Second, they showed that people who were lower in physical fitness estimated hills to be steeper than people who were in better shape. Also, they showed that people who were older and in declining health estimated hills as steeper than younger participants. All of their findings suggested that physical potential and capability influenced perceptual estimates.

To fully understand the influence of physiological potential on the perception of spatial layout, other parameters of space were tested. This allowed for determination of whether the effects of physiological potential on slant were confined to hills, or whether they extended to other aspects of the environment. An additional set of studies examined the influence of fatigue and physiological potential on the perception of horizontal, ground distances. We found that people who wore heavy

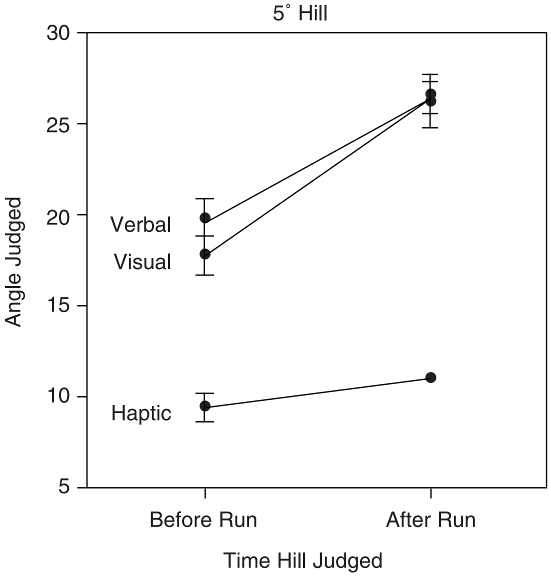

FIGURE 12.3 Mean slant estimates (verbal, visual, and haptic) made by runners before and after their run (from Proffitt et al., 1995). Bars represent ±1 standard error. Reproduced with permission from the Psychonomic Society.

backpacks also overestimated the distance to a target on the ground more than people who were not wearing a pack (Proffitt et al., 2003). Witt et al. (2004) found that people who threw a heavy ball to a target estimated it to be farther away than people who threw light balls. We also examined the perception of distance to a target that was placed either on a hill or on flat terrain (Stefanucci et al., 2005). We hypothesized that distances would be overestimated on steep hills because of the energy required to ascend them, even though this hypothesis was paradoxical given the normal underestimation of distance observed in previous studies. In a series of experiments conducted out of doors and in virtual reality, our findings showed that people overestimated the distance to targets on steep hills even though the geometry of the environment predicted that, given an overestimation of slant, people should underestimate distance.

## INTENTION TO ACT INFLUENCES SPACE PERCEPTION

Clearly the physical capability or potential of observers influences their perception of the environment, but more recent work has shown that an intention to act is also important. The influence of physical ability on perception is specific to the aspect of the environment that is related to the ability. In other words, if one is trying to estimate the size of a small cup one is about to lift, how far one can run is irrelevant. Witt, Proffitt, and Epstein (2005) showed that people holding a long baton estimated distances to be closer to them than people not holding an object that extended their reach. However, this change in the perception of near distances occurred only when the observer intended to wield or use the baton. Thus, the findings suggest that people have to intend to use the baton in order for it to rescale their perception of near space. If they are not going to reach with the baton, objects should not and do not appear closer.

The physical capabilities of people may also change over time, which may change perception. Athletes have good days and bad days, which can change their perception of the environment and also serve to increase or decrease their performance level. For instance, baseball players hitting well have long claimed that the baseball looks as big as a grapefruit. Witt and Proffitt (2005) validated these anecdotal claims. They asked softball players after a winning game to estimate the size of the softball. Their findings showed that the players who hit well remembered the softball as larger than players who did not. These results were then replicated in another sport: golf. Witt, Linkenauger, Bakdash and Proffitt (2008) found that golfers putting well saw the hole as larger than those who were not. Students who participated in a laboratory analog to the experiment also showed changes in perception of the size of a golf hole when they had practiced putting and were putting well. Finally, another set of experiments that examined physical efficacy (ability) and its influence on perception showed that people who had to slide beanbags into a target area estimated the target to be farther away and smaller when the task was more difficult to perform (i.e., sliding the bean bags with their non-dominant hand while their eyes were closed; Franchak, Stefanucci, & Proffitt, 2009).

To summarize, the data from these studies suggests that the efficacy of our actions and our intention to act can influence our perception of the environment. When observers are planning to act, or executing an action, they may see the world differently than those who are not acting. If intentions are able to influence perception, than it is possible that other bodily states, such as emotions, could also influence how we view the world.

## EMOTION INFLUENCES SPACE PERCEPTION

Given that physiological potential and intention to act can influence the perception of spatial layout, is it possible that other bodily states (like emotions) alter perceptions too? Research on the effect of emotion on the perception of spatial layout has surged in the past five years, primarily motivated by research on the perception of faces (Pessoa, Japee, Sturman, & Ungerleider, 2006) and of contrast (Phelps, Ling, & Carrasco, 2006). For example, Phelps et al. (2006) showed that emotion can bias lower-level processes such as perception and can potentiate the effect of covert attention, which also alters perception. More specifically, they demonstrated that when fearful faces were presented before a contrast sensitivity discrimination task (a task that involved discerning whether two surfaces differ in terms of lightness – whether a figure is different than a background), lower thresholds (or differences between the lightness of the surfaces) were needed to perform the discriminations than when neutral faces were presented. In addition, when the face was closer to the target location (and could guide covert attention to the contrast that participants needed to evaluate more quickly) the sensitivity to the contrast was even higher. These researchers concluded that people can "see better" in the context of emotional stimuli. This finding is not at odds with our belief that the overestimation of height or slant when one is afraid could also be adaptive and functional because it would keep the observer from dangerous situations more often.

We began examining the influence of fear on spatial layout by using a skateboard at a hill (Stefanucci, Proffitt, Clore & Parekh, 2008a). Observers were asked to stand on a skateboard (or a box of the same height) and estimate the incline of a 7° hill from the top. Those observers who stood on the skateboard and were scared when they thought about descending the hill on the skateboard estimated the slant of the hill to be greater than those who stood on the box unafraid (see Figure 12.4). As described in the previous section, this overestimation manifested itself in the verbal and visual measures of slant (explicit awareness), but not in the visually guided action measure. Fear influenced the explicit awareness of slant, but did not render people unable to actually descend the hill effectively. The fact that participants did not overestimate with the haptic measure is important because it suggests that they were not simply biasing their responses because they were afraid. If participants believed that we wanted them to overestimate, or intuited our hypothesis, then they likely would have overestimated with all three measures of slant. Given that they did not, we believe that it is more likely that their responses represent a difference in explicit awareness of the slant (verbal and visual measures) and the guidance of action directed at the slant (haptic measure).

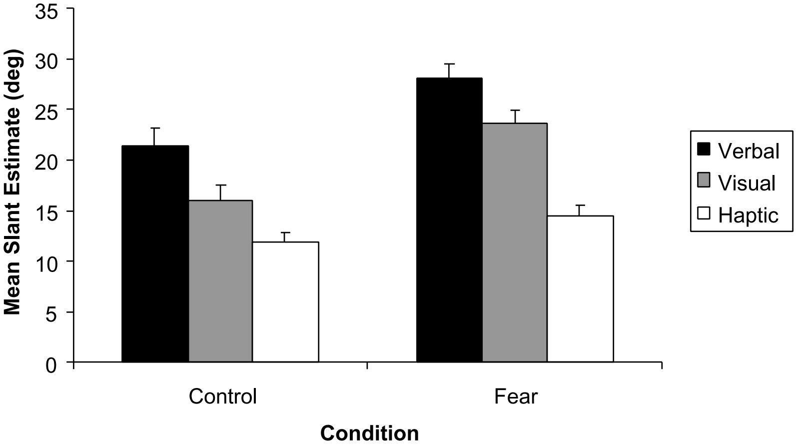

FIGURE 12.4 Mean slant estimates (verbal, visual, and haptic) for the neutral (control) and fear conditions in Stefanucci et al. (2008a). Bars represent + 1 standard error.

The influence of fear on the perception of slant was then tested with another parameter of spatial layout that seemed related to fear: the perception of height. Stefanucci and Proffitt (2009) found that normative perception of heights was correlated with a fear of heights. Specifically, individuals afraid of heights estimated heights as taller than those not afraid. Two measures of fear showed a correlation with height measures: a trait-level measure of fear of heights, the Acrophobia Questionnaire (AQ; Cohen, 1977) and a state-level measure of fears, known as the Subjective Units of Distress Scale (SUDS). The state-level measure simply asks participants to report on their level of anxiety while standing at the height on a scale from 0 to 100 (0 being none at all and 100 being panic level).

To follow up on these correlational findings, Stefanucci, Siegel, Geuss, and Whitley (2008b) tested whether fear of heights could be increased or manipulated if observers had to act on the height. In a particular class offered to undergraduates at the College of William & Mary – the Adventure Games course – students are asked to tackle various height-related challenges during the semester as an individual and in groups of students. First, they are taught to belay and climb rope ladders in a gym. They are also taught how to effectively harness themselves and other students so that they can jump from a height and feel safe. Over the semester, the students are given the opportunity to climb to a zipline (an inclined cable from which participants suspend and travel down while wearing a harness on a moving pulley), crossing a lake in the process. The platform from which they jump to travel down the line is approximately 25 feet high. In our study, we asked the students to estimate the height to the platform from the ground after climbing a tree to get to the platform. We also asked these students, later in the semester, to judge the extent of a parking garage from which they rappelled down the side (40 ft high). So, we garnered two estimates of height from our participants, one from the bottom of a height and one from the top, but both estimates were collected before participants actually acted on the height. We then collected the same height estimates at the same locations from a group of students who were not enrolled in the course and did not act on the height. We found that those participants who were about to rappel off of the building (jumping from the top) overestimated the height more than a group of participants who were not about to jump from the height (students who were not enrolled in the course) (see Figure 12.5). The groups showed no difference in overestimation of height when viewing the zipline platform from below. The results suggest that fear is particularly relevant in modulating perception when a dangerous action is possible.

Next, we tested a group of participants who were particularly afraid of heights (they had high trait-level fears and high scores on the AQ) in order to determine whether individuals more afraid of heights would estimate heights as higher than the less fearful. (Teachman, Stefanucci, Clerkin, Cody, & Proffitt, 2008). Another goal of the study was to determine whether perceptual biases in height fear are related to other cognitive biases observed in people afraid of heights. The findings showed that people high in height fear estimated heights as taller than people who were unafraid. Furthermore, their perceptual biases were significant predictors of height estimation even when controlling for cognitive biases. The findings suggested that increased fear could be a result of perceptual distortions; however, more research is under way to fully understand the possible bidirectional nature of

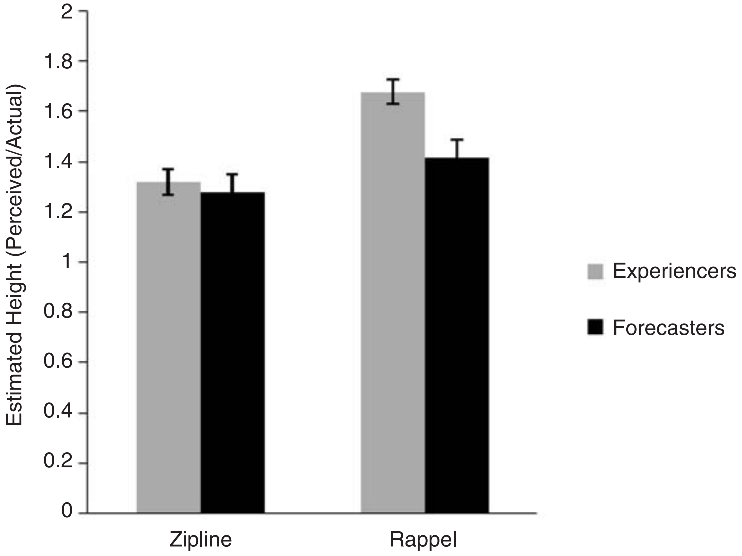

FIGURE 12.5 Mean height estimates for the zipline and rappelling elements presented as ratios (perceived height/actual height) from Stefanucci et al. (2008b). Experiencers were those students enrolled in the course who acted on the height. Forecasters were those students who estimated the height, but were not enrolled in the course and did not act on the height. Bars represent ± 1 standard error.

the relationship between fear and perception. Fear could influence perception, and perception could serve to enhance fear.

Though fear has been the focus of the research examining the influence of emotion on perception, other studies have begun to study more specific aspects of emotions that may alter perceptions. Fear is a multifaceted construct; it can provoke subjective distress, physiological symptoms, changes in motivated behavior, and changes in cognitive processing (see Barlow, 2002). Therefore, we are not sure whether all of the symptoms of a fear reaction, such as heavy breathing, elevated arousal, feeling weakness in the body or paralysis, and cognitive misinterpretations of the situation, contribute to the overestimation of height, slant, and size, or whether one of those factors drives the perceptual distortions. In the simplest case, emotions can be broken down into two constituent parts: a valence and an arousal level. Generally, whether a stimulus seems positive or negative defines its valence, and whether it elicits physiological symptoms, such as changes in heart rate, defines its arousal level.

Both valence and arousal have been shown to influence higher-level cognition independently of one another, so there is reason to believe that they could influence perception either independently or uniquely. Arousal has been shown to influence judgments and decision-making (Gorn, Pham, & Sin, 2001; Sinclair, Mark, & Clore 1994), attention (Easterbrook, 1959; Schupp et al., 2004; Zillmann, 1971), and memory (Cahill, Gorski, & Le, 2003; O'Carroll, Drysdale, Cahill, Shajahan, & Ebmeier, 1999). Emotional valence has been shown to influence these cognitive processes as well (Bless et al., 1996; Gasper & Clore, 2002; Gray, 2001; Gray, Braver, & Raichle, 2002; Storbeck & Clore, 2005). The findings from the research on arousal and valence in higher-level cognition suggest that both arousal and valence could have unique influences on lower-level perceptual processes as they have on higher-level cognitive processes and other potential low-level processes, such as attention.

We began by testing the influence of elevated arousal on height perception (Stefanucci & Storbeck, 2009). In the first experiment, observers were asked to view arousing or non-arousing images for a supposed memory test. The images used were from the International Affective Picture System (IAPS) and arousing images included pictures of violence, sexuality, and other exciting situations, while the non-arousing images included pictures of doors, cups, and other neutral scenes (see Lang, Bradley, & Cuthbert, 1999). For Experiment 1, observers viewed either arousing or non-arousing images before estimating the height of a balcony. They were told that they should try to memorize the pictures while seeing them, because there would be a later memory test. The perceptual estimation task was introduced as a distractor task, one that would take place between the learning and testing for the memory task. In this manner, we could manipulate arousal without necessarily relating it to the height itself. People who viewed arousing images overestimated height more than those who viewed non-arousing images (see Figure 12.6). In a follow-up experiment, we manipulated both valence and arousal using the different IAPS images available in the library (all of the images have been pretested for levels of arousal and valence) and found that only arousal manipulations produced height overestimation.

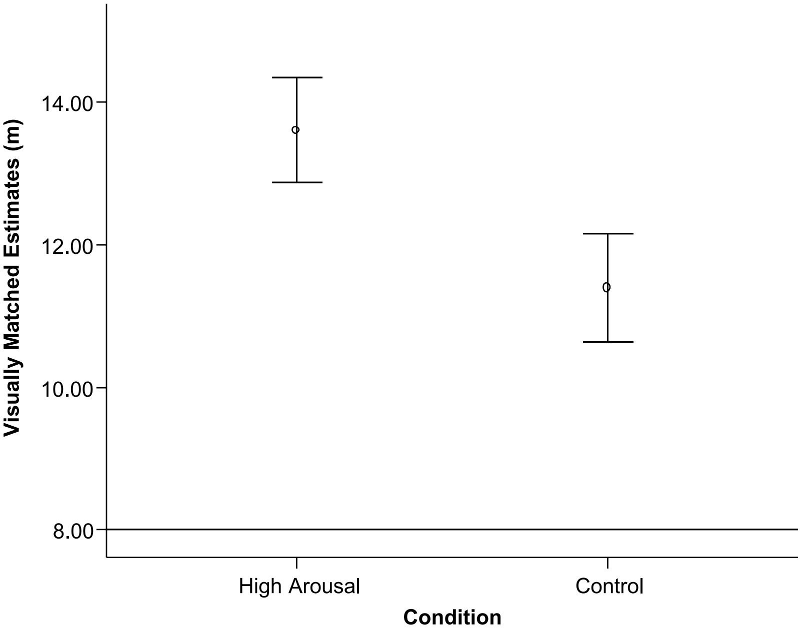

FIGURE 12.6 Mean estimates of height (m) for the arousal and control conditions from Experiment 1 in Stefanucci and Storbeck (2009). All participants viewed the height from the top. Bars represent ± 1 standard error. Copyright © 2009 American Psychological Association. Reprinted with permission.

Valence manipulations did not seem to have an effect on height perception, even though fear is considered to be negatively valenced and this component of fear could have influenced height overestimation in previous studies (Stefanucci & Proffitt, 2009; Teachman et al., 2008). Given that previous research has shown a relationship between fear and height perception, one could believe that this relationship is due to a negative valence in general or fear in particular (an emotion that is intimately related to the perception of heights and slants from above). Valence, when negative, could serve to bias evaluations of the height because if the height seems "negative" it would also likely be seen as taller. In this manner, valence could be used as information for interpreting the height, though the results from the study that included both arousal and valence do not support this hypothesis so far.

In a final experiment in the arousal studies, we asked observers to either up-regulate or down-regulate their emotion while viewing the arousing images. Up-regulation involves asking the participant to think about him or a loved one being the central person in the IAPS picture, whereas down-regulation involves viewing the picture from a detached, third-person perspective. We found that up-regulation of arousal produced further overestimation of height in comparison to the down-regulation of arousal. These initial studies suggest that emotional arousal may be the component of fear that influences estimates of height and that this influence can be moderated by emotion regulation strategies.

Additional research, however, suggested that valence, independent of arousal, can influence the perception of geographical slant. In a series of studies, we manipulated the mood of observers and asked them to estimate slant using the three measures described previously: verbal report, visual matching, and the haptic palmboard (Riener, Stefanucci, Proffitt, & Clore, in press). In one experiment, mood was manipulated by asking participants to listen to either happy music (Mozart's *Eine Kleine Nachtmusik*) or sad music (Mahler's *Adagietto*) for 10 minutes. The music was looped so as to be continuously presented throughout the experiment. While listening to the music, participants gave the three estimates of slant for a five-degree hill. The results indicated that participants in the sad condition visually estimated the hill to be steeper than those in the happy group, and there was a non-significant trend for the verbal measure in the same direction. The haptic estimates were not different across conditions, replicating the previous research on slant perception. In a follow-up experiment, participants' moods were manipulated in a different way. Participants were asked to write about a happy or sad event in their life, instead of listening to happy or sad music. The perceptual task was presented as a distractor task for which participants would take a brief break from their writing, but would then return to it. In this manner, we ensured that the participants would still be "thinking" about their sad or happy life event as they estimated the hill slant. The results from the writing manipulation replicated the results of the music manipulation. Those participants who wrote about a sad life event estimated the hill to be significantly steeper with the verbal and visual measures than participants in the happy condition. Again, there were no differences in the estimates with the haptic palmboard. These results suggest that sadness also has a role in the influence of emotions on perception.

In recent work, we have also examined more closely whether emotional states provoked by thinking about others can also influence the perception of hill slant. Specifically, we questioned whether the perception of hill slant would be reduced when a participant was in the presence of a friend (Schnall, Harber, Stefanucci, & Proffitt, 2008). Borrowing from previous research on the effect of physiological potential on slant perception, we believed that people who viewed the hill while wearing a heavy backpack would overestimate the slant of the hill more when they were alone than when they were with a friend: in essence, that a friend would provide the social support needed to "lighten the load" of the backpack, making the hill look less steep to climb. The findings showed that people who estimated hill slant when with a friend or when thinking of someone who was close to them estimated the hill to be less steep than people who were alone, or thinking of someone they disliked. These findings could be due to a positive emotion that is elicited when thinking about the friend or a negative emotion that is evoked when thinking about an enemy.

Recent research by a co-editor of this book, Emily Balcetis, and her collaborator, David Dunning, has also shown that motivation can influence perception similar to the way that mood, emotion, and social support have been shown to influence perception (Balcetis & Dunning, 2007). In an ingenious set of studies, they showed that a desire to reduce cognitive dissonance influenced observers' estimates of distances and hills. In the first study, participants were assigned to either a high-choice or a low-choice condition, meaning that they were either asked (high choice) or told (low choice) to walk a prescribed distance on campus dressed up as Carmen Miranda. These conditions were used because the high-choice condition created a larger amount of cognitive dissonance in the observers. The second study also incorporated a high- and low-choice condition, but the participants' task was to kneel on a skateboard and to propel themselves up a hill using only their arms. Both studies found that participants not given the choice to do the tasks estimated the distance they had to walk as farther and the slant they had to climb as steeper. These results are important because they extend the previous effects of physiological potential, intention, and emotion on perception to motivational processes.

Not only does motivation influence perception of spatial layout, but Balcetis and Dunning (2006) and Van Ulzen, Semin, Oudejans, and Beek (2007) have argued that it can also influence interpretations of visual illusions. First, Balcetis and Dunning (2006) showed that the motivational state of the observer could influence the way that they interpreted an ambiguous stimulus. For example, if a drawing could be interpreted as a seal or a horse, then participants were more likely to interpret it as the object that gave them the most points for a game they were playing in the experiment. In other words, their desire to see a certain object changed their perception of the ambiguous figure. Van Ulzen et al. (2007) showed participants circles that contained affectively loaded stimuli (pictures from the IAPS library). This study found that circles filled with negative images were judged to be larger than circles filled with positive images, even though the circles were the same size. This misinterpretation of size was also applied to the Ebbinghaus illusion. In their second experiment, Van Ulzen et al. (2007) asked participants to judge the size of the middle circle in the illusion and found that when the target (middle) circle was filled with a negative picture and flanked with circles containing positive images, the illusion was reduced. In other words, the target circle looked bigger when filled with a negative image, so it did not appear as small as it normally would when the illusion is presented with blank circles.

## FUTURE DIRECTIONS

There is a plethora of unanswered research questions regarding the effects of emotion on perception, and answering them will greatly improve our understanding of the relationship between the visual and emotion systems. Does emotion only influence visual perceptions? Do still other emotions influence our perception of the environment? What are the underlying mechanisms by which fear could influence perception? The questions are endless, and we could spend the next 50 years trying to answer them. This chapter thus concludes with a brief description of ongoing attempts to tackle these questions.

First, one of my students, Erika Siegel, is examining whether the effect of emotion extends to other perceptual modalities, beginning with audition. Currently, Siegel is asking participants to write about a fearful or neutral life event when they enter the experiment. Participants are told that we are interested in whether taking a break from writing influences the writing process. They are then asked if they are willing to participate in another experiment in the lab while they are taking a break from writing. The task is to rate the loudness and duration of tones. In truth, the loudness and duration ratings are the variables of interest, but our hypotheses are not revealed until the end of the experiment. We believe that those participants who are writing about a fearful life event will judge tones to be louder and to last longer than participants who write about a neutral life event (see Siegel & Stefanucci, 2010 for results). Anecdotally, many of us have noticed that sounds are particularly loud when we are watching a scary movie. These anecdotal experiences motivated us to test our effects in audition first, but we also have plans to extend the paradigm to olfactory stimuli. Other students in my laboratory are also extending the previous work in vision to other domains, such as the perception of motion rather than spatial layout.

Another line of inquiry concerns the similarity of emotional and physiological states. In the case of fear, there are many relevant physiological symptoms that are produced during a fear reaction (increased heart rate, dizziness, shortness of breath). However, psychological components of fear reactions also include thoughts about losing control and being unable to prevent disaster. In future work, we want to continue defining relationships between the emotional and perceptual systems, but we also want to explore the relative contributions of physiology and cognition to the underlying effects that bodily states (in general) have on perception. We have also begun to examine emotions other than fear and sadness, which are both negatively valenced. For example, we are interested in whether positive emotions can influence perception and, if so, which states and environmental parameters are likely to show the effects. We are also interested in extending our results to the perception of objects within the environment. In one study, we have shown that participants will act on a tool differently if the tool's handle is covered with a disgusting substance.

## HOW MIGHT AFFECT BIAS PERCEPTION?

Finally, we are interested in discovering the mechanisms by which emotion exerts its influence on perception. Research has shown that emotion, arousal, and motivation help shape perception, but how this influence works remains unclear. The influence could be direct or it could be moderated by a third variable. I will discuss possible ways in which emotion and perception could be related below.

When standing at a height, the information available with which to judge the distance to the ground is reduced. Typical cues that are used to scale ground distances, such as the texture on the ground plane or the eyeheight of the observer relative to the horizon, can not be used to scale vertical distances because the observer is not standing on the ground. I believe that the visual system, when in this underspecified situation, takes other information in the brain into account to discover the distance to the ground. In this chapter, I suggest that emotion is one piece of information that could be utilized. In the case of heights, if the observer is standing at the top of the height and is feeling aroused or scared, then she may attribute the emotion to the height and use that information to overestimate the extent. A taller height would certainly be considered more dangerous than a shorter one and would be more likely to produce emotional reactions such as fear or arousal in the observer. Furthermore, once the height is overestimated, then it could be viewed as more dangerous and produce greater feelings of arousal and fear, which would create a cyclical pattern between emotion and perception.

In contrast to the possibility of fear and perception being directly related, one could imagine that an influence of emotion on perception could be moderated by other variables. Attention may help explain how emotion, or arousal and valence, could have such an influence on perception. Attention has been shown to be influenced by emotion in many experiments (Easterbrook, 1959; Schupp et al., 2004; Zillmann, 1971). An influence of emotion on perception could certainly occur because of changes in attentional processing. Easterbrook (1959) found that arousal disrupted vigilance, which could serve to change perception. If an observer is less vigilant at a height because they are aroused and afraid, then this could result in an inaccurate estimation of the height, most likely an overestimation given the danger associated with the situation.

## NEURAL MECHANISMS BY WHICH EMOTION COULD INFLUENCE PERCEPTION

In addition, the neuro-anatomical literature indicates that the perceptual and emotional systems are interconnected in a reciprocal manner. As Amaral, Price, Pitkanen, and Carmichael (1992) report, in the primate visual system, "There is substantial evidence that the amygdala projects to virtually all visually related areas of the temporal and occipital cortex. Thus, the amygdala can potentially modulate sensory processing at very early stages in the cortical hierarchy" (p. 53). Moreover, a series of neuroimaging studies highlight the close link between emotional responding and unique visual processing. Lang et al. (1998) found differences in activations of the visual cortex (BA 18 and 19, primary and secondary visual areas) when participants were shown negative or positive stimuli in comparison to neutral stimuli. Further, in a neuroimaging study on phobics, Fredrikson et al. (1993) asked women afraid of snakes (and who met the criteria for a phobia) to watch three videos while in a PET scanner: one neutral, one unpleasant but without snakes, one unpleasant with snakes. They found greater occipital (BA 18 and BA 19) activation for the unpleasant video with the snakes in comparison to the other videos (see also Reiman, Lane, Ahern, & Schwartz, 1997 and Rauch et al., 1996 for similar findings).

The question of whether emotion influences low-level vision directly, or whether the influence is moderated by another variable, perhaps attention, remains unanswered. Some of the abovementioned studies alter secondary visual areas which are known to be involved with attention processes and can feedback to primary visual areas. In particular, recent research in cognitive neuroscience has shown that attention modulates the activity of cells in the visual cortex (for review see Kastner, 2004). Recently, Pessoa and colleagues (2006) showed that the amygdala can enhance the visual awareness of objects (fearful faces). Duncan and Barrett (2007) also suggest that the affective state of a person may modulate or select those aspects of the environment that reach awareness in a given individual. Likewise, behavioral research in sports psychology found that rock climbers who experienced more anxiety while climbing were unable to detect as many flashes of light during the climbing task compared to the sanguine climbers. The results, along with many from social psychology, suggest that anxiety may narrow the focus of attention, which would have consequences for the amount of perceptual information encoded during a task (Easterbrook, 1959; Pijpers, Oudejans, Bakker, & Beek, 2006). Along these lines, research on attention to negatively valenced targets has shown that negative targets demand more attention than positively valenced targets (Fox, Russo, & Dutton, 2002; Georgiou et al., 2005).

## WHY MIGHT AFFECT INFLUENCE PERCEPTION?

The most important question to consider is why the emotional system might have an influence on the perceptual system. My current feeling is that the influence of emotion on perception exists because it is adaptive and serves to protect the observer. As discussed previously, if the observer perceives the height to be taller than it is, then she may be less likely to act near the height, thereby increasing her safety. Proffitt (2006a) states that any non-visual factor that increases the costs associated with acting in an environment could alter perception. I would also argue that when the perceptual system is trying to solve the problem of how far or how high, and the geometrical information available in the environment is not sufficient, then the system will seek out other sources of information to help with a solution. Emotion, because it conveys information about the costs of our actions, would be a likely source to tap. In addition, this provides interesting possibilities for future experiments, because emotion may not be used to scale the environment in situations that are not dangerous or emotionally evocative. Overall, a relationship between the emotion and perceptual systems would be functional in that it would increase adaptive responses in the observer, which would minimize dangerous actions and increase safety.

## CONCLUDING REMARKS

An enduring question for this research is whether emotion truly influences perception, or whether it influences a post-perceptual response. In other words, the information or the stimulus may be biased at the early stages of processing, or it could be altered at later stages. It would be impossible to find the answer to this debate with current technologies and practices. In behavioral experiments, the observer has to give a perceptual estimate or response in order to determine what they see. So, there will always be the possibility that emotion could have its effects during the response stage rather than the perceptual stage.

I believe that the evidence presented in this chapter suggests that it is perception that is influenced by emotion, not simply responses. The data from many of the studies presented suggest that observers did not necessarily intuit the hypothesis of the experiment and bias their judgments accordingly. For example, in the slant experiments, participants gave three estimates of the slant: verbal reports, visually matched estimates, and a visually guided action response (the haptic palmboard). In Stefanucci et al. (2008a), both the verbal and visual reports were influenced by fear, but the haptic response was not. If participants had intuited our hypothesis, that fear increases estimates of slant, then they should have overestimated slant with all of the dependent measures.

Moreover, the belief that perception is being influenced is supported by converging findings from a variety of measures (both verbal reports and visually matched estimates) for many different aspects of the environment (slant, size, horizontal distances, and vertical distances). For example, Teachman et al. (2008) found that people high in height fear estimated heights to be taller than people low in height fear. Importantly, the high-fear participants also estimated a target on the ground to be larger, suggesting that an indirect measure of the distance (a size estimate) was also influenced by fear. Again, participants may have intuited our hypothesis and biased their height estimates accordingly, but we believe it is unlikely that they also would have known to estimate the target as larger, given that would require understanding that apparent size is related to estimates of apparent height. Furthermore, both the height and size estimates were not verbal reports and extra care was taken to ensure that participants did not know the experiment was about fear and perception. However, I concede that the question remains as to what is being influenced, which provides a plethora of research questions and avenues to pursue in the future.

The visual system was once thought of as a closed and insulated system, but this chapter presents research suggesting that this view should be revised. Instead, vision may be a highly interconnected system in which non-visual information can influence perceptions and perceptions can, in turn, influence cognition.

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# 13

# "Cue, View, Action": An Ecological Approach to Person Perception

JOANN M. MONTEPARE

Snap judgments of people from brief glances pervade our social worlds, and the social-psychological literature is replete with evidence showing that visual information provided by people's faces drives many of these perceptions. The fact that we form impressions on the basis of facial cues is clear. However, knowing why and how we do so is a more complex issue. A variety of mechanisms have been offered to account for appearance-based impressions (Ambady & Skowronski, 2008; Brewer, 1988; Fiske & Neuberg, 1990; Rhodes & Zebrowitz, 2002). The present chapter shows how an ecological approach to person perception has contributed to our understanding of the role of facial cues in impression formation (Montepare & Zebrowitz, 1998; Zebrowitz & Montepare, 2006). Moreover, it provides an example of how social science coupled with visual science can generate new insights about person perception. Unlike more traditional social-psychological models, the ecological approach draws on Gibson's theory of object perception (Gibson, 1979) and calls attention to directly perceptible stimulus information revealed by facial cues that drives the perception of social-behavioral traits. In addition to discussing the distinguishing tenets of the ecological approach to person perception, this chapter describes how accurate innate or prepared responses to age- and emotion-related facial cues produce other far-reaching and biased perceptions of people. To this end, the age- and emotion-overgeneralization effects and their consequences are presented along with a discussion about how perceivers' attunements and aspects of stimulus information shape social impressions.[1]

## THE ECOLOGICAL APPROACH

Early work on first impression cues generated a number of interesting effects. Seminal studies by Secord and associates documented dozens of correlations between physiognomic cues and personality traits (Secord, Dukes, & Bevan, 1954; Secord & Muthard, 1955). Moreover, these face–trait associations showed cross-cultural agreement (Secord & Bevan, 1956) and the impressions persisted regardless of particular social labels attached to the face (Secord, Bevan, & Dukes, 1953). While these findings were intriguing, they were also unsatisfying in that no conceptual framework was available to predict or make sense of the associations that were observed. The ecological approach to person perception was offered to explain such social perceptions (McArthur & Baron, 1983). Moreover, it provided an alternative to more contemporary models of impression formation that, until quite recently, have underestimated or ignored external appearance, focusing instead on internal cognitive mechanisms that process, store and retrieve social knowledge (Gilbert, 1998).

The ecological approach to person perception is grounded in J. J. Gibson's theory of object perception (Gibson, 1979). In contrast to top-down, cognitively driven perspectives, Gibson advocated a bottom-up, sensory-driven approach to understanding visual perception. Furthermore, Gibson's direct approach stresses the importance of understanding an organism's environment in the study of perception and the adaptive value of structured stimulus information the environment provides to active perceivers.

To appreciate how an ecological approach to person perception has informed our understanding of impression formation, it is useful to consider four distinguishing tenets derived from Gibson's theory: Person perception serves an adaptive function, directly perceptible stimulus information drives perceptions, perceptions reflect the detection of behavioral affordances, and attunements to affordances vary and guide perceptions (Zebrowitz,1997; Zebrowitz & Montepare, 2006).

The first tenet reflects Gibson's (1979) dictum that *perceiving is for doing* and maintains that the qualities we perceive in people serve an adaptive function either for the survival of the species or for the goal attainment of individuals. From a long-term evolutionary standpoint, perceptions of people can be seen as solving adaptive inclusive fitness problems concerned with the reproductive success of an individual's genes or an individual's genetic relations (e.g., Cosmides & Tooby, 1997). Viewed from a short-term idiosyncratic standpoint, they can be seen as allowing individuals to manage daily social challenges faced in their lifetimes such as knowing whom to avoid or approach. The adaptive nature of perception within both views assumes that perceptions of people will typically be accurate.

A second hallmark of the ecological approach stresses the significance of qualities in the external stimulus environment that inform person perception. Gibson emphasized the co-evolution of perceptual systems within ecological niches and argued that understanding the nature of organisms' stimulus environment will illuminate how their perceptual systems operate. He also argued that the structural composition and movement patterns of objects are constrained by, and reveal, their inherent internal properties. In the case of person perception, these physical features consist of people's facial appearance and movement, as well as their voice, feel, and scent, which systematically vary with, and reveal, intrinsic human qualities such as age, emotion, sex, identity, and fitness.

In addition to emphasizing the importance of understanding the physical features that inform person perception, the ecological approach specifies the nature of these stimuli. Gibson (1966, 1979) argued that multimodal, dynamic changes over space and time are features that provide the most useful information in nonsocial perception because they reveal higher order invariant properties of objects (e.g., shape, size, and rigidity) and convey objects' behavioral abilities (e.g., grasp-ability), known as affordances (see below). McArthur and Baron (1983) argued that the same is true for person perception. Thus, the multimodal, dynamic stimulus information gleaned by an (inter)active perceiver should provide the most useful information about people's invariant attributes (e.g., age or emotional state) and their behavioral affordances (e.g., vulnerability or hostility). Insufficient or impoverished stimulus information and a preparedness to respond to adaptively significant stimulus information are hypothesized to yield errors that also systematically contribute to impressions of people (McArthur & Baron, 1983; Zebrowitz & Montepare, 2006).

A third distinguishing feature of the ecological approach is an emphasis on the perception of social affordances. Affordances are defined by Gibson (1979, p. 127) as what the stimulus environment "offers the animal, what it provides or furnishes, either for good or ill." To this end, Gibson contended that surfaces afford posture, locomotion and collision; substances afford construction; fires afford warming and burning; detached objects such as tools afford manipulation and other special actions. Or, as Koffka poetically notes in his *Principles of Gestalt Psychology* (Koffka, 1935, cited in McArthur & Baron, 1983), "Each thing says what it is . . . a fruit says 'eat me'; water says 'drink me'; thunder says 'fear me'; and woman says 'love me' " (Gibson, 1979, p. 138). Gibson maintained that the potential for action and consequences of interacting with substances, surfaces, and objects are revealed by their extensional, perceptible physical features. For example, the edibility of fruit is specified by its color, smell, and texture. The grasp-ability of a hammer or a rattle is specified by its shape, size, and rigidity. Applied to person perception, the facial appearance or expressions of children specify their dependency, vulnerability, and approachability.

The fourth tenet of the ecological approach relates to the emergence of affordances from the qualities of the perceiver and the stimulus information. In contrast to constructivist views of person perception, Gibson (1979, pp. 138–139) proposed that:

> The affordance is something that does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived. An affordance is not bestowed upon an object by a need of a perceiver and his act of perceiving it. The object offers what it does because it is what it is.

Thus, the detection of social affordances depends on the perceivers' attunements – their sensitivity to particular stimulus features available in the array of information provided by an object or person. Moreover, what an object affords one perceiver, may not afford another, in that an affordance is an emergent property that depends on the relationship between the perceiver and the object. Attunements may be innate (e.g., men but not monkeys may be attuned to a woman's sexual availability). Attunements also may be educated in a process of perceptual development that varies with perceivers' behavioral capabilities (men but not boys may be attuned to a woman's sexual availability), social goals (secular men but not priests may be attuned to a woman's sexual availability), or perceptual experiences (a lover but not a stranger may be attuned to a woman's sexual availability).

## OVERGENERALIZATION EFFECTS

One especially fruitful hypothesis that has been generated by an ecological approach to person perception is that innate or well-developed attunements to stimulus information produce overgeneralized, and systematically biased, perceptions. More specifically, the overgeneralization hypotheses hold that behavioral affordances or traits accurately revealed by physical features of human qualities that are adaptive to detect will be perceived in individuals who possess similar features. Thus, traits revealed by features that mark age, emotion, sex, identity, or low fitness may be erroneously perceived in people whose appearance resembles that of babies or elders, a particular emotion, men or women, a particular identity, or a particular level of fitness (cf. Montepare & Zebrowitz, 1998; Zebrowitz, 1997; Zebrowitz & Collins, 1997; Zebrowitz & Montepare, 2006). These overgeneralization errors occur because they are less maladaptive than those that might result from failing to respond appropriately to people of a particular age, emotional state, sex, identity, or health status. Surely, greater success at replicating one's genes through successful mating, parenting and kin-directed activities accrues to those who solve the problems of distinguishing infants from adults, anger from happiness, men from women, familiar individuals from strangers, and healthy individuals from unfit ones. Successfully navigating one's immediate social environment also requires the ability to accurately distinguish and respond to diverse people appropriately.

### *Impressions Created by Age Overgeneralizations*

The *babyish-overgeneralization effect* predicted by an age-overgeneralization hypothesis has been the most widely studied effect from an ecological perspective (for reviews see Montepare & Zebrowitz, 1998; Zebrowitz & Montepare, 2008). Starting from the premise that the evolutionary necessity of quick, reliable, and appropriate responses to the needs of babies predisposes perceivers to respond similarly to people with baby-like facial features, it was hypothesized that accurate perceptions of babies would be overgeneralized to babyish-looking adults who consequently are perceived to have childlike traits. The explanatory value of the babyish-overgeneralization effect for understanding impression formation is supported by research examining stimulus information that systematically varies with age, trait impressions, and behavioral reactions created by these facial cues.[2]

The stimulus information that differentiates real babies from adults and comprises a babyface has been identified using a variety of empirical techniques that include objective facial measurements, experimental manipulations of facial cues, and mathematical modeling (Keating, 2002; Montepare & Zebrowitz, 1998; Zebrowitz, 1997). Consistent with Gibson's emphasis on visual invariants gleaned from dynamic changes, this research has shown that both slow- and fast-moving dynamic transformations underlie this information.

The slow-moving growth process from birth to physical maturity is accompanied by systematic changes in the face that reliably specify age (Montepare & Zebrowitz, 1998). One change involves the distinctive remodeling of the cranium from birth to adulthood, and computer modeling techniques have successfully described this invariant spatial quality. Specifically, Todd, Mark, Shaw, and Pittenger (1980) found that age-related changes in head shape could be replicated in facial stimuli using a growth-simulating mathematical transformation called cardioidal strain. Changes in head shape also yield concomitant feature cues to age (Mark & Todd, 1983; Todd et al., 1980) that include a rising of the vertical placement of facial features which in turn produces a decrease in the relative size of the forehead in conjunction with an increase in the relative size of the chin.

Slow-moving maturational transformations also yield changes in facial features that denote age to perceivers (Montepare & Zebrowitz, 1998). Infants' eyes are relatively larger than those of adults because the eyes grow little from birth whereas the face continues to grow, making adults' eyes smaller in relation to the face. Infants also have smaller noses with a more concave bridge and are relatively wider than they are long. With maturation, noses become larger with a more prominent bridge and relatively longer than they are wide, particularly for men (Enlow, 1990; Hess, 1970; Lorenz, 1943). Age-related changes in facial and cranial hair also occur during the early stages of maturation. Infants have smoothly textured skin with thin, high eyebrows, and their heads are bald or covered with fine hair. With age, facial, eyebrow, and scalp hair become thicker, especially for men at the time of puberty (Enlow, 1990).

Though less well understood, more immediate fast-moving facial transformations provide visual cues that perceivers can use to extract age information. Using Johannson's (1973) point-light technique to isolate variations in the movement of an object independent of its structure, Berry (1990a) showed that facial movements were an effective cue to age. In her research, small pieces of reflective tape were affixed to the faces of children, young adults, and older adults who were videotaped while talking with another person or reciting the alphabet. When the tapes were replayed with the brightness reduced and the contrast maximized, the pattern of a person's facial movements appeared as moving masses of luminous dots. Viewers' age judgments were more accurate from these point-light displays than from still frames of the point-light tapes, and viewers accurately classified the faces at better than chance levels with the age labels *child, young adult*, and *older adult*.

The validity of age-specifying cues in eliciting perceptions of babyishness in adult faces has been demonstrated in correlation and experimental studies, showing that faces with larger eyes; higher eyebrows; smaller nose bridges; rounder and less angular faces; and lower vertical placement of features, which creates a higher forehead and a shorter chin, are perceived as more babyish (Zebrowitz & Montepare, 2008). Connectionist modeling research has demonstrated further the validity of babyface cues by ascertaining the extent to which adult faces activate a neural network trained to identify babies' faces. This research has shown that those adult faces that a neural network finds more structurally similar to babies are indeed perceived as more babyfaced by human raters (Zebrowitz, Fellous, Mignault, & Andreoletti, 2003). Consistent with the importance of multimodal information stressed by Gibson, research has also found that multiple facial feature composites often account for greater variance in babyish perceptions than individual features (Berry & McArthur, 1986; Zebrowitz & Montepare, 2008). However, more research is needed to identity the role of fast-moving dynamic cues in specifying babyishness.

Confirming predictions from a babyish-overgeneralization hypothesis, research has shown that people with a more babyfaced appearance are perceived to have more childlike traits. In particular, babyfaced adults are perceived to be more vulnerable, naïve, submissive, physically weak, warm, and honest than their maturefaced peers – just as actual babies are perceived to be (Montepare & Zebrowitz, 1998). Moreover, robust associations between babyfaceness and trait impressions occur across the life span. Thus, there are babyfaced infants, children and adolescents as well as babyfaced younger and older adults – all of whom are perceived to have more childlike traits than their mature-looking peers (Zebrowitz & Montepare, 1992). It is important to note that several design aspects of this research support the claim that reactions to visual cues yielded trait impressions as opposed to mere age stereotyping or spurious trait attributions. For one thing, the observed babyface effects remained significant even when the perceived chronological age and attractiveness of the facial targets was statistically controlled. As well, trait judgments and facial appearance judgments were collected from independent groups of perceivers to reduce the possibility of any carryover effects. Finally, participants were not told that the research concerned babyfaceness, and the debriefing of participants routinely failed to reveal that they were consciously aware of the manipulated facial dimension. Evidence for cross-cultural agreement in perceptions of babyfaceness (Zebrowitz, Montepare, & Lee, 1993; Keating, Randall, Kendrick, & Gutshall, 2003) together with reactions by infants and young children (Keating & Bai, 1986; Kramer, Zebrowitz, San Giovanni, & Sherak 1995; Montepare & Zebrowitz-McArthur, 1989) support further the argument that impressions yielded by babyfaceness reflect a basic response to age-related facial stimulus information.

Considerable research has also shown that overgeneralized reactions to facial babyishness extend beyond first impressions and have far-reaching implications across a variety of social domains (for a review, see Montepare & Zebrowitz, 1998). For example, just as babies are perceived to be cognitively and socially immature, individuals with babyfaces are passed over for mentally challenging tasks and leadership positions. On the other hand, just as babies are perceived to be approachable and cheery, adults with babyfaces are favored for jobs that require congeniality. And they are more likely than maturefaced peers to be exonerated when charged with intentional crimes, but more likely to be found at fault when charged with negligence. Babyfaced individuals are also more likely to receive more help from others than their maturefaced peers. Moreover, a number of the observed consequences have been found across age and cultural groups (e.g., Keating et al, 2003).

Are overgeneralized impressions of people with babyfaces accurate? Limited research addressing this question has produced mixed results. Berry and colleagues found that more babyfaced college students are in fact warmer and less aggressive (Berry, 1990b, 1991; Berry & Landry, 1997). However, other researchers using a representative longitudinal sample found that only older adult women displayed personality traits consistent with impressions of babyfaced individuals (Zebrowitz, Collins, & Dutta, 1998b). In contrast, impressions of babyfaced adolescent boys were inaccurate. Compared with maturefaced boys, babyfaced boys were more negative, quarrelsome, assertive, and hostile, and showed higher academic achievement, all of which contradict impressions of babyfaced individuals (Zebrowitz, Andreoletti, Collins, Lee, & Blumenthal, 1998a; Zebrowitz et al., 1998b). In addition, more babyfaced young men were likely to earn military awards, contradicting impressions of submissiveness and physical weakness (Collins & Zebrowitz, 1995). Moreover, in a sample of adolescent boys at risk for delinquency, those who were more babyfaced were more likely to be delinquent and, if delinquent, to commit more offenses (Zebrowitz & Lee, 1999).

The mixed results surrounding accuracy highlight the need to consider the origins of actual relationships between babyfaceness and traits. The behavior of babyfaced boys and young men that contradicts impressions did not appear to reflect a more immature physical or social status given that the effects held true when measures of height, masculinity, and actual age were controlled. A more plausible explanation is that the findings reflect a self-defeating prophecy effect, whereby babyfaced males counter the undesirable expectation that they will exhibit childlike traits by behaving in a contrary way (Zebrowitz et al., 1998a). The failure of babyfaced girls to show contradictory behavior, and the tendency for older babyfaced women to confirm the stereotype, may be explained by the fact that childlike traits parallel stereotypes of femininity (Zebrowitz et al., 1998b). Thus, babyfaced young girls may not try to refute expectations, and babyfaced women may ultimately confirm them as a self-fulfilling prophecy. In addition, sample differences may account for the inconsistencies among the studies. For example, the babyfaced adolescents who show antisocial behavior that contradicts impressions of their physical and social weakness may not be found in the college samples where babyfaced individuals show lower aggressiveness.

## *Impressions Created by Emotion Overgeneralizations*

From an ecological perspective, the adaptive value of recognizing and responding to emotional expressions may have produced such strong attunement to emotion cues that perceivers overgeneralize accurate perceptions of emotion affordances to people whose facial features bear a resemblance to emotion cues. What are the affordances of emotional expressions? Drawing on Darwin's (1872) evolutionary view of the adaptive value of emotion expressions for social communication, some nonverbal theorists suggest that beyond providing information about people's affective states, facial expressions of emotion also reveal information about people's behavioral intentions (Ekman, 1997; Ekman & Friesen, 1975; Fridlund, 1994), or, in ecological terms, their affordances. In particular, displays of emotion may signal approach, attack or avoidance, which convey to perceivers the likely affiliativeness or dominance of a person's behavior in addition to how happy, angry or afraid a person feels. For example, happiness may be viewed as an approach expression that conveys to perceivers a person's positive affective state as well as a person's likelihood of acting in a friendly, confident, and assertive way. On the other hand, anger may be viewed as an attack expression that conveys a person's likelihood of acting in a domineering, hostile, and unfriendly manner. Consistent with the notion of *temporal extension* (Secord, 1958), an angry person may then be viewed not only as likely to act momentarily in an unaffiliative or dominant way, but also as possessing enduring unaffiliative or dominant traits (e.g., unsociable, unfriendly, unsympathetic, cold, forceful).

Like research in babyfaceness, research on emotional expressions has identified a variety of static and dynamic visual cues that yield perceptions of basic emotions. Well-known work by Paul Ekman (2003; Ekman & Friesen, 1975) has described configurations of static facial features that signal happiness, fear, anger, sadness, surprise, and disgust. Other researchers have observed similar facial patterns across the life span, in young infants as well as in younger and older adults (Izard, 1994; Izard et al., 1995; Malatesta, Izard, Culver, & Nicholich, 1987).

Research using facial point-light displays has shown that dynamic cues also provide reliable emotion information (Bassili, 1978). As well, more abstract cues have been implicated in emotion perceptions. In particular, Larson, Aronoff, and Stearns (2007) showed that simple shapes containing a downward-pointing "V," which is similar to the geometric configuration of the face in angry expressions, were perceived as threatening and detected faster than identical shapes pointing upward. In another study, Bar and Neta (2006) demonstrated that low-level configural properties of objects (i.e., sharp angles vs. curved edges) gave rise to high-level affective judgments (i.e., dislike, threat, aggression). Aronoff and colleagues (Aronoff, Barclay, & Stevenson, 1988; Aronoff, Woike, & Hyman, 1992) found similar relationships between angular (curved) patterns and negative (positive) affective response to objects as well as evidence for cross-cultural generality by showing that the design of primitive masks across diverse cultures incorporated variations in diagonality and angularity to convey messages about anger and threat. Montepare (2007) offered evidence for the information value of abstract dynamic cues in research exploring perceptions of the emotionality of computer-generated circular shapes made to expand and contract at different speeds (slow, moderate, fast) in different planes (frontal, horizontal, vertical). Whereas frontally expanding shapes were perceived as happy or angry, frontally contracting shapes were perceived as sad or fearful. The speed of change appeared to moderate distinctions among perceptions (e.g., expanding shapes were perceived as more pleasant, especially at faster speeds).

Although it is evident that a variety of static and dynamic facial qualities serve as potent emotion cues, it is not yet understood why particular emotion expressions look the way they do. One possible answer is that particular facial expressions alter certain physiological states via muscle actions that prepare individuals for adaptive behavioral actions, as an extension of the vascular theory of emotional efference might suggest (Zajonc, Murphy, & Inglehart, 1989). This theory argues that cognitively unmediated facial feedback can have a considerable impact on felt or experienced emotions by way of facial muscle contractions that impact venous blood flow and hypothalamic temperature. Thus, particular facial configurations or movements may prepare for and signal the emotion-related actions of approach, attack, and avoidance. Another answer, which also has implications for the associated trait impressions, was proposed by Marsh, Adams, and Kleck (2005a), who suggested that both the morphology of emotion expressions and the impressions they elicit derive from the adaptive utility of their mimicking variations in facial maturity. In particular they argued that fear and anger expressions evolved to mimic baby's faces and mature faces, respectively.

Consistent with the hypothesized affordance value of emotional expressions, research has also found that people's transient emotional expressions significantly impact perceptions of their traits. People displaying happy expressions are perceived to possess traits associated with high affiliation and high dominance, and those displaying angry expressions are perceived to have traits associated with high dominance and low affiliation (Hess, Blairy, & Kleck, 2000; Knutson, 1996; Montepare & Dobish, 2003). Expressions of sadness and fear elicit impressions of traits associated with low dominance and moderate affiliation (Hess et al., 2000; Knutson, 1996; Montepare & Dobish, 2003). Interestingly, although fear expressions are judged as unpleasant, they facilitate approach behaviors in perceivers (Marsh, Ambady, & Kleck, 2005b). One interpretation is that although fear expressions afford unsociable responses, they also invite help and assistance.

Research on *emotion overgeneralization effects* has further shown that trait impressions of people are elicited by the resemblance of their permanent facial qualities to an emotional expression. In particular, Montepare and Dobish (2003) found that some neutral expression faces create perceptions of an angry demeanor and elicit impressions of low affiliative traits; others create perceptions of a happy demeanor and elicit impressions of high affiliative traits. Given links between babyfaceness, attractiveness and emotion-based trait impressions, it is possible that the trait impressions of neutral expression faces were mediated by their babyfaceness or attractiveness. However, the influence on trait impressions of neutral faces' resemblance to emotion expressions held up when babyfaceness and attractiveness were statistically controlled. Thus, there is an emotion overgeneralization effect in impressions of neutral expression faces that derives from a structural resemblance to emotion expressions that is independent of these other facial qualities. However, the particular qualities of the resemblance have not yet been articulated as in the case of babyish-overgeneralization effects.

In contrast to what is known about the social consequences of babyish-overgeneralizations, no research has examined the impact of emotion-overgeneralizations beyond first impressions. Thus, many questions remain about the extent to which individuals with particular emotion-related facial features are treated differently in particular social situations. Will individuals with happy facial demeanors be more likely to be considered as better suited for particular jobs or leadership positions compared to equally qualified peers with angry or sad demeanors? Will they be treated differently for purported transgressions or crimes they have committed? Will they be more readily helped when in need? Future research must address these questions. As well, although the perception of emotion from facial expressions has cross-cultural and cross-age generality (Ekman, 1994; Izard, 1994), research is needed to determine whether emotion information creates consensual trait impressions and overgeneralization effects across perceivers from different cultural and age groups as has been found for babyfaceness.

The accuracy of trait impressions from emotion expressions and emotion overgeneralizations also has received little attention. However, one study that examined the accuracy of trait impressions elicited by emotion cues suggests that neutral faces whose structural properties resemble an emotion expression may provide accurate trait information, at least in older adults. In particular, Malatesta, Fiore, and Messina (1987) found a positive relationship between ratings of the emotional facial demeanor of older adult women posing neutral expressions and their scores on trait scales of emotional dispositions. For example, women whose neutral faces looked angry actually scored higher on a hostile personality dimension. Whether such effects reflect the remodeling of the face over time as a function of recurrent emotion expressions or some other process remains to be determined, as does the generality of accuracy when judging younger adult faces.

## VARIATIONS IN PERCEIVERS' ATTUNEMENTS

Regardless of the potential underlying information value of physical cues, an ecological approach holds that the detection of social affordances from these cues ultimately depends on the perceivers' attunements – their sensitivity to cues that reveal particular affordances. In contrast to more familiar top-down *constructivist* approaches to person perception, the ecological approach reflects a more bottom-up *realistic* view in which attunements capture the notion that what a person perceives in faces depends on not only what valid information exists but also what information the person is sensitized to or is able to detect and what information is useful to that perceiver. Attunements may be universal as well as individualized. For example, while all humans may be attuned to the affordances of a baby face, individual differences will emerge in perceivers' sensitivity as a function of their perceptual experiences derived from social, motivational, cognitive, and related factors.[3]

It should be noted that the construct of *interpersonal sensitivity*, widely studied by nonverbal behavior theorists (DePaulo & Friedman, 1998; Hall & Bernieri, 2001), may be seen as related to the concept of perceptual attunement. Although the measurement of interpersonal sensitivity has been debated among nonverbal researchers, it is agreed that individual differences captured by all interpersonal sensitivity views are an important component in the perception of nonverbal information. An ecological approach also recognizes the importance of individual perceivers' sensitivity to stimulus information. However, whereas interpersonal sensitivity is conceptualized as an individual difference trait that predicts accuracy in decoding nonverbal cues, attunements reflect the extent to which individuals are sensitive to information that accurately reveals particular behavioral capacities. Moreover, the ecological approach does not view such sensitivity as a stable personal trait. Like attunements, interpersonal sensitivity is assumed to be sculpted by perceptual learning as well as innate mechanisms. However, research on interpersonal sensitivity has more traditionally focused on general comparisons across different age, gender, race, cultural or other social groups.[4] An ecological approach calls for a more emergent view of sensitivity that considers adaptive or functional relationships between perceivers and people in their social environment that impact perceivers' reactions to particular affordances specified by nonverbal cues. An ecological approach also calls for greater attention to the immediate social context and how varying social needs, motives, and goals might impact perceivers' attunements to particular information in distinct situations.

Although much of the existing ecological research on impression formation has focused on more general attunements to basic affordances (e.g., see discussion of social consequences of babyishness in Montepare & Zebrowitz, 1998), related research is accumulating that speaks to more individualized attunements. The following discussion provides examples from this research to demonstrate the ways in which visual attunements may vary across perceivers.

Attunements are continually sensitized by perceivers' unique perceptual experiences, reflecting what ecological theorists have called the "education of attention" which leads to finer discriminations of stimulus information and the detection of affordances (Gibson, 1969, 2000, 2003). In this view, different social contexts provide training grounds for perceivers that yield fine-tuned differences in their attunements to particular social affordances. For example, research has found that perceivers identify the facial expressions of members of their own cultural group more accurately than those of members of another cultural group (Elfenbein & Ambady, 2002, 2003). And Elfenbein (2006) has demonstrated that providing perceivers with feedback about their emotion judgments not only improves their overall accuracy in judging facial expressions, but also greatly enhances their ability to decipher the emotional expressions of individuals from cultural groups distant from their own.

Perceptual experiences gained through social roles and relationships also contribute to individual differences in perceivers' visual attunements. Early primate research indicated that parental status was associated with adult female monkeys' attention to infant monkeys. Mothers who had recently delivered infants showed a greater preference for baby-viewing than did mothers who were pregnant or females who had never given birth (Cross & Harlow, 1963). More recent research with humans shows similar reactions. Studying cerebral responses of adults, this research observed that parental status, as well as gender, affected visual cortical responses to facial expressions of unfamiliar infants. In particular, parents and women exhibited stronger responses to infants' displays of happy and distressed expressions than did non-parents and men (Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006).

From the child's perspective, research has found that infants prefer their own mother's face to the face of other females (Bushnell, 2001), with greater levels of exposure showing stronger preferences. Moreover, mother–child attachment experiences can have long-lasting consequences. For instance, neural imaging research with adult women has found not only greater activation in particular brain regions in response to their mothers' faces, but also differences in response patterns to the faces of their mother versus faces of female friends and strangers (Ramasubbu et al., 2007). The impact of parent–child experiences is seen further in research showing that physically abused children, presumed to have experienced high levels of threat and hostility, accurately identify facial displays of anger on the basis of less sensory input than do non-abused children (Pollak & Sinha, 2002).

With increasing age and more varied social experiences, attunements to emotional stimuli continue to adjust. In particular, research has shown that adults identify facial expressions of peers from their own age group more readily than those from a different adult age group (Malatesta et al., 1987). Some research with aging adults also has shown that older adults are more attuned to positive than negative stimuli compared to younger adults, owing to what theorists argue is older adults' greater focus on emotion regulation coupled with age-related changes in affective neural functioning (Mather et al., 2004; Mather & Carstensen, 2005). Thus, older adults report experiencing fewer negative emotions, and when shown faces that vary in affective valence the happier ones are selectively processed (Mather & Carstensen, 2005).[5] However, the intrinsic value of some emotional stimuli appears to remain intact with advancing age, insofar as research has shown that angry faces get noticed equally quickly by older and younger adults (Mather & Knight, 2006).

Individual differences in motivation have been examined as a moderating factor in the perception of facial cues in a variety of studies. For example, several nonverbal researchers have considered the impact of positive motivational states on the processing of nonverbal cues. However, this work has produced weak or mixed results. For example, whereas Nowicki and Richman (1985) found no impact of a monetary incentive on perceivers' ability to judge facial expressions, Klein and Hodges (2002) found that a monetary reward enhanced the accuracy of perceivers' emotion judgments. Manipulations involving ego relevance implying high intelligence (Forrest & Felman, 2000) and forewarning (Hall & Schmid Mast, 2008) have likewise produced mixed results in research on sensitivity to facial expressions. From an ecological perspective, a more emergent approach may be more productive in examining the impact of motivation on perceivers' attunements to facial cues: that is, one that considers the objective of particular motives with respect to the relationship between the perceiver and what is perceived. For instance, might motives that reflect what an individual can gain or lose from another person impact more systematically on their sensitivity?

Along these lines, intriguing research by Schultheiss and Hale (2007) demonstrates how particular motives systematically influence responses to certain cues. According to these researchers, people's implicit motives sensitize them to cues that reflect desired incentives and signal aversive disincentives. Testing this model using a dot-probe task featuring faces with anger, joy, surprise, and neutral expressions, they found that affiliation-motivated individuals show vigilance for angry faces signaling low affiliation (rejection) and tend to orient their attention towards happy faces signaling high affiliation (acceptance), presumably because interactions with individuals who afford these traits are more likely to allow them to fulfill their social goals. On the other hand, power-motivated perceivers orient their attention towards expressions signaling low dominance (i.e., surprise) and away from expressions signaling high dominance (i.e., anger and joy), presumably because interactions with dominant individuals have the capacity to thwart a power-motivated person's capacity to dominate others. The observed reactions of power-motivated individuals is consistent with social relations research showing that highly assertive men and women, who tend to dominate others, prefer to date babyfaced rather than maturefaced people (Hadden & Brownlow, 1991).

Other clever research suggests that motives in broader social contexts induced by environmental conditions can also yield variations in visual attunements. More specifically, in an analysis of the popularity of American movie actresses between 1939 and 1997, Pettijohn and Tesser (1999) found a systematic relationship between the facial appearance of celebrities and the social and economic conditions of the times. When social and economic conditions were stagnant and pessimistic, more mature-looking actresses were popular, presumably reflecting the greater sense of security and protection conveyed by their appearance. When social and economic conditions were prosperous and optimistic, actresses with more babyish faces were popular, presumably reflecting the greater sense of frivolity and playfulness afforded by their appearance. In a conceptual follow-up study, Pettijohn and Tesser (2005) experimentally manipulated situation threat and gave participants the choice of a babyish or mature female partner with whom to interact. Consistent with the broader social context effects they observed, preference for mature-looking partners increased under high threat whereas preference for babyish-looking partners increased under low threat. More research is clearly needed to expand our understanding of the purposeful interplay of social motives, relationships, and attunements.

Perceivers' attunements are surely linked to their neural signatures, which can reflect personal experiential factors as well as general innate adaptations. Social neuroscience research has been examining a variety of neural substrates that play a role not only in how we perceive faces, but specifically in how we perceive faces that vary with respect to their emotional expression and age (Zebrowitz, 2006). Although emotion expressions generally elicit more activation than neutral expressions in the limbic regions of the brain, differentiating activation to different emotional expressions has proved to be a complex issue, with multiple interacting pathways involved (Wager et al., 2007). Nevertheless, a look at one general pathway reveals how attunements may be associated with neural mechanisms. For example, perceptions of fear- or threat-related stimuli have been associated with the amygdala, which responds rapidly to arousing emotional stimuli (Ledoux, 2002; Phelps, 2006), and even prior to perceivers' awareness (Whalen et al., 1998). Research has also found that faces of babies *and* faces of babyfaced men elicit greater activation in the amygdala than do maturefaced men, which is consistent with the emotional salience of babyfaceness (Zebrowitz, Luevano, Bronstad, & Aharon, 2007). Consistent with Gibson's view of the primacy and information value of visual stimuli, some theorists have suggested that the amygdala facilitates emotional perceptions by altering sensory cortical processing via feedback to the visual cortex (Kapp, Supple, & Whalen, 1994; Ledoux, 2002).

Emerging research suggests that naturally variant or clinically compromised amygdala functioning can impact perceivers' visual attunements to particular stimulus information. For instance, individuals with amygdala damage show significant impairments in their ability to process arousing fear-related stimuli (Adolphs, 2006). Provocative research indicates that approximately 8.8% of healthy men (from a sample of 341 tested within a university environment who showed no significant differences in IQ) display deficits in processing emotional stimuli akin to those seen with acquired amygdala damage (Corden, Critchley, Skuse, & Dolan, 2006). And differences in amygdala functioning and the processing of emotional stimuli have been observed in men versus women (Koch et al., 2007) and shy versus bold adults (Beaton et al., 2008) as well as among individuals manifesting anxiety disorders and social phobias (Etkin & Wager, 2007). How these differences play out with respect to social affordances perceived in fear-related facial cues will be interesting for future researchers to investigate, as will be an examination of how variations in neural functioning impact reactions to affordances specified by other arousing emotion-related face cues.

An intriguing study by Heberlein and Adolphs (2004) examined the ability of different perceivers to anthropomorphize – or the tendency to perceive affective and social qualities in inanimate objects. To this end, they showed Heider and Simmel's (1944) classic film of geometric shapes moving around a box to non-damaged and amygdala-damaged perceivers. Whereas non-damaged perceivers described the shapes as having affective traits and social intentions (often involving themes of fear, dominance and intimidation), perceivers with amygdala damage merely described the actual movements of the shapes without reference to any emotional or social qualities. More research needs to be done to understand this interesting phenomenon. As well, the extent to which associations observed between amygdala functioning – as well as other neural mechanisms – and perceivers' abilities and personal traits contribute to their perceptions of behavioral affordances is a fruitful topic for researchers to explore.

## VARIATIONS IN STIMULUS SALIENCE

Although the foregoing discussion suggests that perceivers' visual attunements determine which stimulus information is most salient and readily detected, it has only considered reactions to stimuli along specific dimensions (i.e., age or emotion). However, people in our social world vary along diverse, complex stimulus dimensions (e.g., age, culture, race, sex, emotion, familiarity, attractiveness, fitness). Thus, it is instructive to consider the nature of relative stimulus salience in the person perception process. Understanding how, which and when particular dimensions are likely to impact judgments about people are important issues that have received little attention in contrast to that given to visual attunements in the ecological literature. These topics are explored below.

Although researchers have recognized the complexity of human attributes, their discussions have been rather fragmented and focused mainly on select dimensions. For example, Mackie and colleagues have argued that cues that mark sex will typically be the most salient social dimension in people's judgments due to the dichotomous nature and social emphasis of sex as a social category (Mackie, Hamilton, Susskind, & Rosselli, 1996). On the other hand, it may be countered that cues that mark age will be the most salient to perceivers because age identification is more likely to be diagnostic of behavior than identification based on sex or race. Consistent with this argument, age emerged as a salient category marker in research by Kogan (1974), who asked individuals to sort photographs of either male or female faces of different ages expressing varying degrees of smiling into categories. In his research, individuals classified the faces more on the basis of their perceived age than on the basis of their perceived traits or interpersonal appeal. Research by Milord (1978), however, has suggested that other facial cues may be more salient. In his research, a multidimensional scaling procedure was used to examine the relative salience of age, sex, race, and affect under different task conditions. When the length of time individuals looked at faces was examined, age emerged as the dimension that moderated other responses. However, when they were asked to select the face they most preferred, expression emerged as the most salient dimension. On the other hand, when they were asked simply to rate the degree of similarity between faces, race emerged as the most salient dimension.

Using a novel methodology, Montepare and Opeyo (2002) explored the relative salience of facial cues to age, sex, race, and emotion. Inspired by the Stroop interference effect, participants viewed pairs of schematic faces on a computer that differed simultaneously along two facial dimensions (e.g., race and age) and were prompted to make similarity judgments about the faces along one of the dimensions (e.g., race). On a second round of trials, judgments were made along the other dimension (e.g., age). Analysis of response speed and accuracy revealed that participants judged the race of the faces more quickly and with fewer errors compared to their age, gender, or emotional expression.

As can be seen, determining differences in the salience of stimulus dimensions is a challenging task, especially given that many findings are tied to the nature of the particular research methodology that was used. For example, when studies differ in the tasks perceivers are asked to perform (with some using explicit and others using implicit measures), they are more likely to produce different results. As well, when studies use stimulus faces that vary in the availability of particular information (as is the case when using photographs versus schematic drawings or when static versus dynamic faces are used), they may also yield different results. It is also important to consider how the sample of faces used in particular studies impacts perceivers' reactions. For example, the salience of race in Montepare and Opeyo's (2002) study may have been pronounced because black stimulus faces appeared as frequently as white stimulus faces to perceivers who might typically expect fewer encounters with black faces. This possibility highlights not only the need for researchers to consider how the parameters of face samples guide perceptions of individual faces but also, not surprisingly, how differences in perceivers' visual attunements to diverse racial groups impact their sensitivity to particular stimulus dimensions.

More comparable studies with greater attention to the nature of the information available in facial stimuli would certainly help to identify better the potential salience of particular social dimensions. However, there are several alternative ways in which stimulus salience may be examined. One way is to examine the differential impact of stimulus information within the context of *actual* trait impressions, as opposed to measures of preference, similarity or reaction time. Montepare and Zebrowitz (1998) compared the effects sizes of studies that examined the relative impact of age cues on appearance-based trait impressions in comparison to the effects of sex cues. Their analysis showed that the effects of age cues on trait impressions equaled or exceeded the contribution of targets' sex cues when the targets' actual age did not vary (as in the case of research on babyfaced adults). These researchers also compared the impact of babyishness and attractiveness on trait impressions. Although babyishness and attractiveness were similarly related to perceptions of greater social goodness, babyishness was a stronger predictor of traits reflecting social, physical, and intellectual weakness. However, it is important to note that this line of research was designed to examine the predictive value of babyishness, and in doing so focused on trait impressions that were conceptually linked to age cues.

Another way to explore the salience of particular stimulus dimensions is to consider its information potential in particular social contexts. According to ecological theory, the relative influence of a particular stimulus dimension versus other social dimensions will depend on which dimension specifies more information pertinent to perceivers' most pressing goals – i.e., which category specifies the most relevant opportunities for acting, interacting, or being acted upon. That will depend of course on the goals that are evoked in a particular social context. Thus, to determine the relative salience of particular dimensions in social judgments, one must consider what information is provided by one dimension in a particular social context and whether it is more revealing than that specified by another dimension. To do this systematically requires a taxonomy of affordances, something that remains to be developed (but see Kelley, 1997, for a promising framework in which to do so). In the absence of a taxonomy of affordances, the following thought experiments draw on the four bipolar dimensions of interpersonal behavior in Wiggins' (1979) circumplex model to suggest how certain social stimulus dimensions might specify the most relevant and salient affordances in comparison to those potentially provided by other consequential social dimensions.

Consider a social context that is conducive to dominant or submissive behavior. Perhaps you are on a hiking tour that has lost its way. Who will afford you the leadership that you need? Although a person's sex or race may influence the likelihood that they will do so or are elected to do so, age may matter even more. An adult of any sex or race is more likely to provide leadership than a child. Moreover, an adult with a happy facial demeanor is likely to suggest a leader who is affable as well as confident and assertive compared to one with a less affiliative, angry-looking face.

Consider a social context that is conducive to gregarious or aloof behavior.

Perhaps you are deciding whom to sit beside on a park bench while you eat your lunch. Who will afford you a pleasant social interaction? A person's sex or race may influence the likelihood of affiliation, but age will matter more. A child or an elderly adult is more likely to respond positively to friendly overtures than is an adolescent or young adult of any sex or race. (This may be less true now that children are taught to be wary of strangers, but the fact that this must be taught supports the point.) And a child or elderly adult with a happy expression or affable-looking face will likely afford the most responsive interaction.

Consider a social context that is conducive to ingenuous or calculating behavior. Perhaps you are looking for a coveted item on a scavenger hunt during a neighborhood picnic. Who will afford you the information that you need to help your team win the prize? A person's sex or race may influence the likelihood of doing so, but age has an influence as well. Young children are less likely than adults to mislead you by withholding information that is known to them.

Consider a social context that is conducive to agreeable or quarrelsome behavior. Perhaps you have to tell shoppers that the store has run out of the promised free items. Who is likely to give you a hard time? A person's sex or race may influence the likelihood of conflict, but age may have an even larger effect. "Terrible" two-year-olds, "rebellious" adolescents, and "testy" elderly adults may show more quarrelsome behavior than young adults of any sex or race, as would an irritated, angry customer of any age.

The foregoing thought experiments offer a host of opportunities for further research exploring the nature and impact of stimulus salience in social perception. Coupled with an emphasis on the role of variations in visual attunements, future empirical work taking an ecological approach will certainly provide us with a fuller and broader understanding of appearance-based impressions.

## BOTTOM-UP AND TOP-DOWN INTERACTIONS

Although an ecological approach places the perception of affordances provided by people's directly perceptible physical characteristics at the center of the person perception process, it recognizes the complexity of human social behavior and the value of other, cognitive mechanisms in arriving at judgments about people. However, little research has examined how these bottom-up and top-down processes might operate in concert. One example of how this interaction might occur comes from work looking at the allocation of cognitive resources in social judgments.

Without doubt, perceivers routinely encounter information about people from multiple sources in their daily interactions, and perceptual and cognitive mechanisms are continually at work processing this information to arrive at social judgments. Drawing on the conceptualization of person perception as a multilevel system involving both lower (or bottom-up) and higher (or top-down) processing mechanisms (Gilbert & Krull, 1988; Gilbert, Pelham, & Krull, 1988), it may be argued that attention to facial information reflects a bottom-up judgment process that occurs automatically given the visual salience and communicative affordances of facial cues. In contrast, attention to other types of information involves a higher-order judgment process that requires more extensive cognitive effort to utilize. Given these distinctions, it may then be hypothesized that when perceivers encounter different or conflicting information (as they routinely do) and attempt to make a social judgment, they will attend to the most immediately informative cues when their cognitive resources are strained. When cognitive demands are reduced, other information will draw perceivers' attention. To explore the merit of this view, Montepare (2002) manipulated perceivers' level of cognitive demand as they attempted to make emotion judgments and examined the consequences. To test this, perceivers were given discrepant combinations of facial information (i.e., photographs of targets' facial expressions) and situational information (i.e., brief stories about an emotional event) reflecting targets' emotional experiences, and asked to make judgments about the targets' emotional state. One group of perceivers was asked to do this while attempting to remember a list of items to be bought at the grocery store. Results showed that perceivers' judgments more often reflected facial information when demands were placed on perceivers' cognitive resources. In contrast, situational information had the greatest impact when cognitive demands were minimized on perceivers.

Work by Patterson and Stockbridge (1998) shows a related effect. More specifically, the accuracy with which perceivers made judgments from nonverbal cues about people's social status and relationships was significantly greater under high versus low cognitive demand. The improved accuracy of participants' first impression under high cognitive demand was consistent with the work of Gilbert and colleagues, who found that increased cognitive demand facilitated accuracy in person perception judgments when the salient information about a target was vocal, rather than verbal, in nature (Gilbert & Krull, 1988; Gilbert et al., 1988).

These few empirical examples are consistent with the claim that directly perceptible physical stimuli are an adaptive and fundamental source of information for social perceivers. When perceivers need to make rapid judgments about people, as is often called for in daily social situations, their attunement to people's faces is heightened relative to other sources of information, especially as perceivers are cognitively multitasking. The extent to which this holds true across different stimulus dimensions (e.g., emotion versus age; face versus voice or body) is for future research to examine, as is the extent to which cognitive demands impact more far-reaching social consequences of face-based judgments.

## LOOKING FORWARD

The theory and research described in this chapter illustrate how an ecological approach to person perception functions in exploring and explaining appearance-based impressions. Drawing on Gibson's presumptions about the nature of visual perception, the ecological approach brings into focus the interplay of stimulus information, social affordances, and perceivers' attunements in driving adaptive and predictable perceptions of people in a diverse social environment. Given that this approach reflects a broad theoretical perspective as opposed to a single sovereign theory, there are many original and distinctive hypotheses that can be generated from the guiding framework. For example, it would be useful to develop and test hypotheses that predict the relative impact of information specified across different physical modalities (i.e., face versus voice versus body, etc.). In one research study, Zebrowitz-McArthur and Montepare (1989) found that whereas a babyish face contributed more to impressions of people's warmth, a mature-sounding voice contributed more to impressions of people's power. An adequate explanation for these findings has yet to be determined from an ecological perspective. In addition, there are many extensions of existing tenets to be pursued. As noted above, no taxonomy exists to describe the affordances relevant to human social perceptions. In addition, despite its emphasis on the emergent nature of affordances, research conducted within the ecological approach has yet to give adequate attention to examining perceivers' interactions and reactions in actual social encounters. As well, much more can be learned about the nature of stimulus information, especially configural and dynamic cues. Finally, building theoretical bridges between the bottom-up, perceptually driven ecological approach and top-down cognitively based approaches offers rich opportunities for collaborations among social scientists.

## NOTES

1. For the brevity of discussion and ease of illustration, the present chapter focused on two of several overgeneralization effects that have been documented and studied. For information on identity overgeneralizations, fitness overgeneralizations, and anomalous face overgeneralizations see Zebrowitz and Montepare (2006, 2008).
2. It is also possible that the functional value of appropriate responses to the behavioral qualities of elderly adults may predispose people to respond in a similar fashion to those whose physical features are similar to those of old people. The result may be an *elderly-overgeneralization effect* – accurate perceptions of the elderly are overgeneralized to older-looking, -sounding, and -moving younger adults. Such *age-overgeneralizations*, produced by perceivers' sensitivity to age-related physical information, may help to explain impressions elicited by people with particular physical attributes (see Montepare & Zebrowitz, 1998 for further discussion).
3. The impact of these factors on social perceivers' perceptual experiences may be interpreted as a juncture or interaction between bottom-up and top-down processes. While this may be true, it is important to recognize that an ecological approach nevertheless views the outcome of this activity as a perceptual one characterized by greater specificity in the sensitivity of the perceptual system to affordances conveyed by particular stimulus information.
4. More recent attention in the nonverbal literature has begun to broaden the scope of interpersonal sensitivity. For an excellent overview of these developments see Hall and Bernieri (2001).
5. It should be noted that other researchers have found a negativity rather than a positivity bias effect in older adults (Grühn, Smith, & Baltes, 2005). Nevertheless, either type of selective attunement is of interest within an ecological perspective.

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