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The Regulation of Vision

How Motivation and Emotion Shape What We See

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A thoughtful introductory psychology student could be excused for wondering why their course textbook might include chapters on sensation and perception. After all, aren't these functions things that the *eyes* do (in the case of vision)? What does perception have to do with the *mind*—and with the motivations and personalities that define us? The answer is, quite a lot. Even the limited amount of information available to our senses during a passing glance is enough to overflow our capacity for awareness, and thus the contents of awareness are largely driven by what our mind prioritizes, either because of our explicit goals or because of some reflexive attraction. In a very real sense, our motivations and emotional responses regulate what we see.

The idea that our perception of the external world can be shaped by our internal motivations and emotions has held appeal through much of the history of psychological thought. There is something provocative about the notion that aspects of the mind are interconnected even at the earliest information-processing stages. Studies within the "New Look" movement, for example, fired the imagination of researchers across the world, as they seemed to provide increasing evidence that perception itself is shaped by a person's needs, values, and motivations (e.g., Bruner, 1957; Bruner & Goodman, 1947). Although many of these studies have been criticized on methodological and theoretical grounds (e.g., see Pylyshyn, 1999), research supporting this core notion has gone through periods of revival, often with increased methodological rigor (e.g., Balcetis & Dunning, 2010). Readers interested in reviewing recent work along these lines will find much of value in the chapter by Balcetis and Cole in the current volume.

At first glance, the notion that knowledge and internal states can shape perception appears to run counter to suggestions that early visual processing proceeds without input from higher level processes—suggestions that early vision is cognitively "impenetrable" (Pylyshyn, 1999)—but there is room for reconciliation. Even if one accepts as true the hypothesis that early visual computations proceed automatically and are insulated from the influence of knowledge, motivation, expectation, and emotion, the contents of conscious perception are additionally shaped by processes that determine both the input into the earliest stages of visual analysis (e.g., attention) and the handling of its output (Pylyshyn, 1999). Readers interested in how perception is shaped by rapid, unconscious, and surprisingly sophisticated inferences at a post-input stage of processing may wish to examine the fascinating literature on "indirect perception" (e.g., Rock, 1983, 1997). The material covered in the present chapter focuses on how attention guides "input" stages of visual processing, with profound consequences for conscious perception, and how this influence is shaped by our expectations, our goals, and our emotional responses to our surroundings.

THE EMBARRASSINGLY IMPOVERISHED NATURE OF PERCEPTION WITHOUT ATTENTION

The trust we place in our senses to deliver details of our environment to our conscious awareness is somewhat misplaced. When it comes to seeing, despite deeply held intuitions that it is simply a matter of pointing one's eyes in the right direction, what the mind sees can be quite different from what the eyes register. Perhaps no experiment of the past 50 years illustrates the central role of anticipation and attention in perception more effectively than the now-famous "gorilla experiment" (Simons & Chabris, 1999), in which participants watched a videotape of three players in white shirts and three players in black shirts passing a basketball among themselves. Participants counted the number of passes made by one of the two teams, and as a result of their concentration on the task they were oblivious to the fact that—partway through the video—a person in a full-body gorilla outfit casually strolled through the middle of the scene, remaining visible for several seconds. In short, because participants' attention was preoccupied by the pass-counting task, they failed to notice the gorilla despite looking directly at it. This phenomenon is known as *inattentional blindness* (Mack & Rock, 1998).

It is important to note that other phenomena—in addition to inattentional blindness—have also illustrated the impoverished nature of perception in the absence of attention. For example, the widely studied "attentional blink" refers to instances where people fail to see the second of two rapidly presented targets when it follows too soon after a first target: attention to the first target appears to tie up attentional resources that otherwise could have been allocated to the second target, leading that second target to escape awareness (e.g., Chun & Potter, 1995; Di Lollo et al., 2005; Raymond, Shapiro, & Arnell, 1992). But what is particularly striking about inattentional blindness is that whereas the attentional blink occurs because of attention's temporal limitations, inattentional blindness occurs even when the unexpected stimulus is in plain view for an extended period of time (e.g., Most et al., 2001; Most et al., 2005b; Most, 2013). In essence, rather than occurring due to lab-centric manipulations designed to push the limits of attentional resolution, inattentional blindness appears to stem from a volitional misallocation of attention based on a person's assumptions about what they should prioritize, as well as a lack of anticipation for the critical item. (Indeed, because a lack of anticipation is an essential factor, inattentional blindness experiments often involve only one critical trial per participant, making them time-consuming to run; once participants are probed for their awareness of the stimulus, its occurrence on subsequent trials is no longer unexpected and inattentional blindness largely disappears.)

Given the robustness of inattentional blindness, one might expect the phenomenon to be familiar to most people and commonly recognized as a frequent occurrence. Yet, it runs so counter to such deeply held intuitions about perception that its discovery came as a surprise even to many vision experts. Among experts, part of this surprise stemmed from the fact that it seemed to contradict previous evidence that certain types of features could reach awareness in the absence of attention (e.g., Treisman & Gelade, 1980). In contrast, inattentional blindness experiments revealed that even features that appeared to "pop out" in the context of other attention tasks failed to reach awareness when they were unexpected and when attention was preoccupied (Mack & Rock, 1998). In broader society, outside the world of vision experts, under-appreciation of the power and frequency of inattentional blindness has led to dangerous behavior (e.g., driving while talking on a mobile phone) and to misattributions of the causes of people's behaviors, some of which have resulted in legal decisions that have changed lives. For example, in 1995, Boston police officer Kenny Conley was pursuing a shooting suspect on foot when he passed by an ongoing, brutal beating of an undercover police officer whom other officers had mistaken for the suspect. Conley continued his pursuit without stopping. Questioned later in court about why he failed to stop, he claimed that he had not seen the assault. Because the beating had been in plain view, the judge and jury assumed he was lying, and Conley was sentenced to nearly three years in jail for perjury and obstruction of justice (see Chabris et al., 2011). In the wake of this case, a team of investigators simulated the incident: participants were instructed to chase a confederate on a path that brought them past several other confederates engaged in a mock fight. As a means to preoccupy attention, participants were asked to count the total number of times that the runner ahead of them touched his head. Even when this experiment was conducted in broad daylight, almost half of the participants failed to notice the mock fight (Chabris et al., 2011). Clearly, people have intuitions about perception that are as prevalent and strongly held as they are wrong (Chabris & Simons, 2010).

GOAL-DRIVEN VS. STIMULUS-DRIVEN ORIENTING OF ATTENTION

William James famously stated that "everyone knows what attention is," but in truth "attention" refers to a family of mechanisms that is more complex than lay intuition would suggest. At the most general level, "attention" refers to a family of mechanisms that converge to prioritize processing of some aspects of our experience over others. What we attend to is not always under our strict control. *Endogenous* (or goal-driven) shifts of attention refer to those instances when we actively choose to focus on something that interests us, but in some cases attention can seem to shift without our volition. This distraction can be stimulus-driven, or *exogenous*: features that are particularly unique in the environment and stimuli that seem to appear abruptly via a sudden onset have proven to be particularly powerful attentional magnets (Theeuwes, 1992, 1994; Yantis & Jonides, 1984), as have emotional stimuli, which attract attention more robustly than do non-emotional stimuli (e.g., Anderson, 2005; Anderson & Phelps, 2001; Öhman, Flykt, & Esteves, 2001; Vuilleumier & Huang, 2009; cf. Awh, Belpolosky, & Theeuwes, 2012).

Framed in terms of motivational states, attention can be guided by our goals (on the basis of what might be considered "explicit" motivation), but attention can sometimes shift reflexively, often because of—among other factors—our emotional responses to things. (Whereas reflexive shifts sometimes occur without apparent regard for a person's goals, when they occur in response to emotional stimuli they could be said to stem from "implicit" motivation, given the link between emotion and approach-withdrawal action tendencies; e.g,. Carver, 2006; Harmon-Jones, 2003; see also Harmon-Jones, Price, & Harmon-Jones, this volume, and Carver, Johnson, & Joormann, this volume). Given that what we attend to helps determine what we become aware of, this suggests that our goals and emotions have the power literally to shape what we see. The following pages provide a brief overview of research on the contribution of both goals and emotions to perception, focusing on the work we have conducted in my lab and in collaboration with my colleagues.

GOALS

An antsy pedestrian at a crosswalk might eagerly anticipate the onset of a walk signal. A driver merging onto the highway might scan for other cars but less so for motorcycles. A person on a blind date might look for the telltale outfit of his or her suitor. It is often the case that we come to a scene with an idea in mind of what we should be looking for—that is, with goals that guide attention and thus help shape what we see (see Maner & Leo, this volume, for additional interesting work on motivation and attention). A common metaphor for attention is that of a "spotlight" that we move around the visual environment to illuminate whatever falls within its beam (e.g., Posner, 1980). And certainly we are able to shift attention from one spot to another voluntarily. Note, though, that this metaphor emphasizes attention in space ("spatial attention"), but this is not the only basis on which people are able to select information. People also have the ability to tune their attention for certain features (i.e., establish a feature-based "attentional set"; Folk, Remington, & Johnston, 1992). Consider, for example, the famous children's book series *Where's Waldo* (also called *Where's Wally* in some parts of the world), where readers need to find the protagonist within densely packed scenes of people and places; because readers know that Waldo always wears red stripes, they might establish an attentional set for that color, leading all red items in the scene to become salient. When people seek or prepare to respond to specific visual features, strong interconnections between prefrontal cortical areas and visual areas such as the inferior temporal cortex help enable the strategic modulation of stimulus-linked responsiveness in the latter regions (e.g., Desimone & Duncan, 1995).

In short, people are able both to orient attention to the spatial location they expect to be relevant and to tune attention to prioritize the visual features that they expect to be important. Contrary to possible assumptions that attention to locations and to features reflect simply different manifestations of the same selection mechanism, evidence suggests that they have different consequences for visual awareness. For example, in a computerized analogue of the gorilla experiment, participants viewed a dynamic rectangular display in which a set of black shapes and a set of white shapes moved around a display, occasionally coming into contact with a horizontal line that bisected the display (Most et al., 2000). Participants counted the number of times that one of these sets of shapes touched the line on each of several trials, and on a critical trial a unique gray shape entered the display from the right, traveled slowly on a horizontal path, and exited to the left. Crucially, the shape's horizontal path ran either along the line or at varying distances away from it. Although participants were more likely to notice the unexpected object the closer it appeared to the line—which was presumably the focus of spatial attention—this influence on noticing rate was modest. In fact, fewer than half of the participants noticed the unexpected object when its path overlapped completely with the horizontal line. Additional striking evidence for the modest role of spatial attention in shaping awareness comes from experiments that have combined inattentional blindness tasks with eye-tracking. In a version of the gorilla study, for instance, people who saw and who failed to see the gorilla did not differ in the number of times they looked directly at it (Memmert, 2006). It seems that when a person has no expectation that an object will appear, the proximity of its appearance to the locus of spatial attention has only a small impact on awareness.

In contrast, the tuning of attention for particular properties appears to have profound consequences for conscious perception. For example, in a variation of the computerized task described above, four black and four white items moved through a computerized display and participants kept track of either the black or white shapes during each of several trials, counting the number of times that their target set of shapes bounced off the display edges. On a critical trial, a new, unexpected object entered the display and remained visible for about 5 seconds. When the unexpected object was white, 94% of those tracking white items noticed it, but no one tracking black items did. This pattern reversed when the

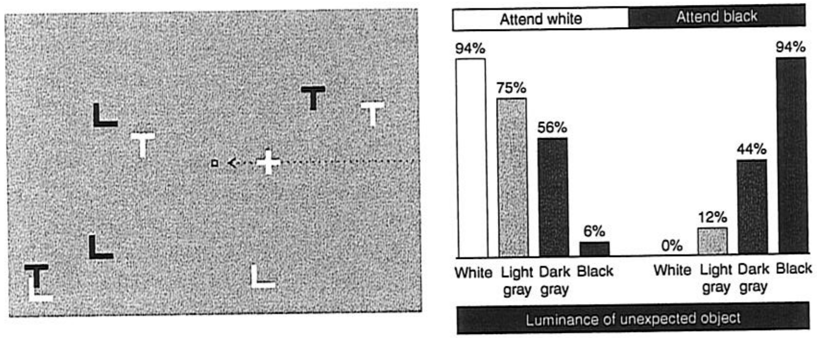

Figure 9.1 Participants viewed a display in which four white and four black shapes moved about the screen, and they counted the number of times that one of the two sets of shapes bounced off the edges of the display (left). On a critical trial, a cross that was either white, light gray, dark gray, or black unexpectedly entered from the right, traveled across a fixation point, and exited to the left, remaining visible for about 5 seconds. The proportion of participants who noticed the cross depended on how similar its luminance was to the luminance participants had "set" themselves to track (right). Adapted from Most et al., 2001, 2005b.

unexpected object was black, and noticing rates were intermediate when the unexpected object was gray (Most et al., 2001). In other words, the more similar the unexpected object was to the targets' features, and the less similar it was to the distractors' features, the more likely it was to be seen (see Figure 9.1).

Note that this ability to tune attention is not limited to the brightness dimension. It is flexible. For example, in a follow-up experiment, participants viewed a display in which two black squares, two white squares, two black circles, and two white circles moved on independent paths, and on each trial participants counted the bounces made either by the four white shapes, the four black shapes, the four circles, or the four squares. On the critical trial, the unexpected object that appeared was a black circle. Replicating the experiment described above, participants counting the bounces made by the black shapes were more likely to notice the unexpected black circle than were those counting the bounces made by the white shapes. Crucially, a similar pattern emerged when people tuned their attention on the basis of shape: those counting the bounces made by circles (black and white combined) were more likely to notice the unexpected black circle than were those counting the bounces made by squares (Most et al., 2005b, Experiment 1).

Notably, people also had the ability to tune their attention for complex arrangements of features, such as those that constitute the most social of stimuli: faces. When people tracked Caucasian faces, they were more likely to notice an additional unexpected Caucasian face that entered the display than a luminance-matched African-American face, and this pattern flipped among people who were tracking African-American faces (Most et al., 2005b, Experiment 3). More recently, it has been shown that people can also tune their

attention for the number of items they expect to appear, which modulates their awareness of an unexpected object (White & Davies, 2008).

Seeing in Search of Meaning

Of course, it would be misleading to suggest that people are always scanning their surroundings for particular, well-defined visual features. The world resonates with the meanings that we assign to objects, people, and events, and given the rapid and seemingly effortless way that people categorize things, the question arises as to whether people can tune attention for *meaning* in a way that also affects visual perception. Strikingly, the answer appears to be that they can. For example, in another variation of the dynamic computerized display described above, the attended and ignored items were sets of block-like digits and numbers. On the critical trial, the letter 'E' or its mirror reverse—a block letter '3'—unexpectedly traveled across the display, and despite the fact that they shared nearly all features, people were more likely to notice the 'E' when tracking the letters than when tracking the numbers, and they were more likely to notice the '3' when tracking the numbers than when tracking the letters (Most, 2013).

At first glance, such findings may seem contrary to arguments that early vision is cognitively impenetrable (Pylyshyn, 1999); it is one thing, one might say, to suggest that the input into early stages of vision can be filtered through a lens that selects for visual features, but it is quite another to suggest that such a filter operates after analysis of semantic meaning has taken place (e.g., Deutsch & Deutsch, 1963). Indeed, there are possible alternative explanations. For example, letters tend to have their open sides facing to the right whereas digits do not, so it is possible that the apparent impact of attentional set for meaning merely reflected a tuning for this featural difference between the stimulus sets. However, in an experiment from another lab, participants saw 1-second displays, each containing two pictures of animals and two pictures of furniture. In a between-subjects manipulation they were asked to identify the stimuli from one of the two categories. On a critical trial, letters spelling out the name of a piece of furniture (e.g., "table") or the name of a type of animal (e.g., "cat") appeared among the pictures, and participants were more likely to notice the word when it belonged to the same category as the pictures to which they were attending (Koivisto & Revonsuo, 2007). Note that this finding cannot be attributed to attentional set for visual features themselves. It thus does appear that people can tune their attention in search of meaning in such a way as to affect what they see.

Although such findings have the potential to be construed as evidence that the earliest stages of visual processing must be subject to the influence of high-level semantic knowledge, the "cognitive impenetrability" hypothesis pertains largely to computations upon information that has been selected for early visual processing, not to how such information is selected in the first place. How might high-level knowledge help guide such selection? Some insight might be gained through the recognition that the passage of information through the visual system is not unidirectional: visual processing does not proceed in linear, "bottom-up" fashion, with simpler visual analyses always preceding more complex analyses. Rather, connections throughout the visual system are largely "reentrant," with communication between regions incorporating iterative feedback loops that allow the output of one stage of analysis to revise and refine analyses at earlier stages (e.g., DiLollo, Enns, & Rensink, 2000; Felleman & Van Essen, 1991). The notion that higher levels of analysis can help guide the pick-up of information at earlier visual processing stages is reminiscent of the "perceptual cycle" model proposed by Neisser (1976), wherein the initial pickup of roughly detailed information gives rise to hypotheses and expectations about the visual scene, which in turn guide subsequent shifts of attention and accrual of further information. In this way, conscious perception is said to emerge through a bootstrapping process. Although somewhat vaguely characterized, this conceptualization of perception may illustrate how initial expectations and hypotheses regarding the semantic properties of visual stimuli can guide attentional selection—and thus shape perceptual experience—while allowing early perceptual computations themselves to remain unaltered by such high-level processes.

Real-world Consequences of Goal-based Attentional Tuning

The experiments described above suggest that a person's goal-driven attentional tuning can frequently be a dominant factor determining awareness. But how applicable is this to everyday life? Failures to see an unexpected shape on a computer screen have no consequence, but what about unexpected objects and people that cross our path in the real world? If a child runs in front of a speeding car, one might expect that the potential consequences of the driver failing to see her would be enough to lead to an instant prioritization of that information, leading the presence of the child to break through to the driver's awareness. Indeed, as will be discussed in the section on emotions below, emotionally relevant stimuli do tend to enjoy perceptual priority. However, in a recent driving simulation study, we found that the power of goal-driven attentional tuning was such that it influenced noticing under conditions that more closely mimicked what would be a high-stakes scenario in real life. In that experiment, participants "drove" through a virtual cityscape and at each intersection encountered a road sign with blue and yellow arrows pointing in different directions (Most & Astur, 2007). Half of the participants were instructed to follow the yellow arrow at each intersection and half were instructed to follow the blue arrow (thus, establishing an attentional set for either yellow or blue). At a critical intersection, an oncoming motorcycle veered into the driver's path and came to a stop. Crucially, the color of the motorcycle was either blue or yellow, so that it either matched or did not match the driver's attentional set (all combinations were counterbalanced). The results were striking: when the color of the motorcycle matched drivers' attentional set, only 7% of participants collided with it. In contrast, when the motorcycle did not match drivers' attentional set, collision rate skyrocketed to 36%.

Interim Summary

As my colleagues and I have stated elsewhere, to a large degree "what you see is what you set" (Most et al., 2005b): people have a tendency to see what they have tuned themselves to see and to miss other things. We often enter places and situations with an *a priori* idea in mind of the people and objects we expect to be important, and such goal-related attentional preparation can heavily influence what we become aware of.

EMOTIONS

Because most aspects of the environment reverberate with emotional meaning, understanding perception in the real world necessitates understanding how it is impacted by emotion. Evidence suggests that emotional stimuli themselves tend to capture attention and sometimes are perceived under conditions where non-emotional stimuli would typically go unnoticed (e.g., Anderson & Phelps, 2001; Fox et al., 2001; MacLeod, Mathews, & Tata, 1986; Öhman, Flykt, & Esteves, 2001; Vuilleumier & Huang, 2009). Given the combination of the power of emotional stimuli to grab attention and the impoverished nature of perception in the absence of attention, one might predict that encounters with emotional stimuli would have the potential to "blind" people to other things in the environment. And indeed, this does seem to be the case. For example, my colleagues and I discovered that the rapid presentation of an emotional picture could impair people's ability to see subsequent targets, an effect we labeled *emotion-induced blindness*. On each trial, participants viewed a rapid serial sequence of upright landscape photos (presented at a rate of 100-ms/item) and within each stream searched for a single target (a landscape photo rotated 90-degrees clockwise or counterclockwise). When an emotional distractor (e.g., a picture of violence or medical trauma) appeared in the stream just before the target, people spontaneously experienced a brief period of functional "blindness": for about half a second, people became unable to perceive the target that they were searching for even though it appeared right in front of their eyes (see Figure 9.2). This pattern appears to reflect a disruption of conscious perception rather than disrupted maintenance of information in visual working memory, as the size of the effect is comparable regardless of whether participants respond immediately or withhold their response for a brief delay (Kennedy and Most, 2012). Furthermore, this effect seems to stem from the arousal induced by the emotional stimuli, not by their valence (positive vs. negative): in one set of studies, we included a set of erotic pictures as critical distractors—which both men and women tend to rate as emotionally arousing and emotionally positive (Bradley et al., 2001)—and these caused at least as much emotion-induced blindness as did the emotionally aversive distractors (Most et al., 2007). In fact, when participants were offered up to $90 for high target accuracy, their performance in the negative condition improved slightly but no such improvement occurred following the erotic distractors.

In a recent extension of our emotion-induced blindness research, people monitored two simultaneous rapid streams for the target, and the emotional

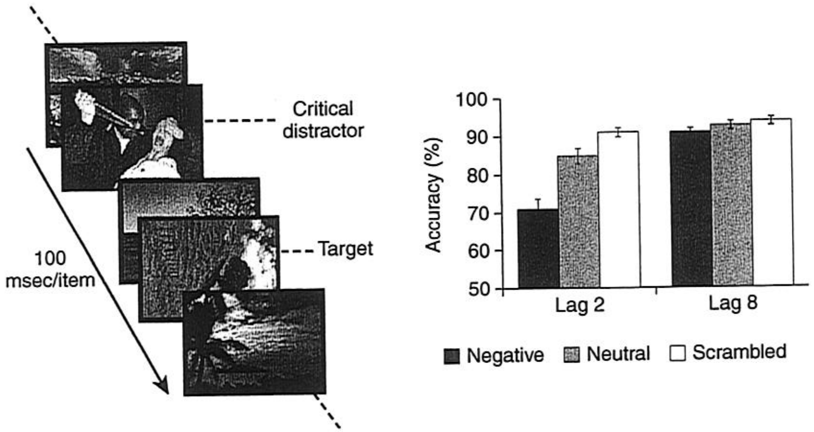

Figure 9.2 Schematic of part of an emotion-induced blindness trial (left) and data from an emotion-induced blindness experiment (right; Most et al., 2005a). On each trial, participants viewed a rapid stream of landscape photos and searched for the one landscape photo that was rotated 90-degrees clockwise or counter-clockwise. On most trials, an irrelevant critical distractor appeared prior to the target. When the critical distractor was emotional and preceded the target by only two items ("lag 2"; as pictured here), accuracy in reporting the target suffered relative to when the critical distractor was non-emotional. This effect was transient: when the target appeared eight items after the distractor ("lag 8"), emotion-induced blindness dissipated. Adapted from Most et al., 2005a; Wang, Kennedy, & Most, 2012.

distractor appeared in either the same or opposite stream as the target. The results of this experiment were surprising: rather than inducing an across-the-board impairment in target perception, emotional distractors primarily disrupted perception at their location, leaving target perception elsewhere in the visual field intact (Most & Wang, 2011).

The apparent spatial localization of emotion-induced blindness is surprising because it is commonly found that emotional stimuli attract and hold spatial attention, thereby *facilitating* perception of subsequent targets appearing at their location (e.g., Jiang et al., 2006; MacLeod, Mathews, & Tata, 1986; Mogg & Bradley, 1999; Van Damme, Crombez, & Notebaert, 2008). This has usually been demonstrated through changes in response time: for example, when an emotional stimulus appears in one of two possible target locations, people respond faster to a subsequent target at that location than in the opposite location. The widely accepted explanation for this effect is that because emotional stimuli capture spatial attention, people are able to process targets appearing at that location without having to "reorient" attention, a time-consuming process that leads to longer response times when the target appears elsewhere. Individual differences in the tendency to orient spatial attention to the location of an emotional stimulus have been used to inform information-processing models of

emotional disorders (e.g., Mathews & Mackintosh, 1998; Mogg & Bradley, 1998; Williams et al., 1997), with related research exploring whether such attentional biases play a causal role in emotional disorders (Mathews & MacLeod, 2002).

Note, however, that the theoretical and empirical endeavors within this literature rely heavily on indexes of *spatial* attention shifts, and there are at least two important limitations to this approach. First, as noted previously in this chapter, the ability to move attention around in space is only one of a family of attention mechanisms that allow us to sample, select, and prioritize information within our environments. Second, increasing evidence suggests a dissociation between indices of spatial attention shifts and conscious awareness: that is, it is possible to shift spatial attention to a location without becoming aware of stimuli at that location (Kentridge, Heywood, & Weiskrantz, 1999, 2004; Lambert et al., 1999; McCormick, 1997; Woodman & Luck, 2003). Thus, studies that focus on individual differences in orienting to the location of an emotional stimulus (or disengaging from that location; Fox et al., 2001) may grant only partial insight into the nature and treatment of emotional disorders, which are often characterized by heightened awareness of emotionally negative information at the expense of competing emotionally positive or non-emotional aspects of the environment.

The spatially localized nature of emotion-induced blindness is also surprising within the context of the broader visual cognition literature. In fact, it is difficult to account for it using contemporary understanding of the attentional blink, which on the surface seems to be the most closely related phenomenon. Decades of research on the attentional blink have suggested that it reflects perceptual disruption at a late, relatively central stage of processing, such as limitations in the ability to consolidate targets into visual working memory (Chun & Potter, 1995; for alternative accounts that also implicate late-stage or central resources, see Di Lollo et al., 2005; Shapiro, Raymond, & Arnell, 1994). The implication of such central bottleneck accounts is that the perceptual disruption should occur across the visual field, and indeed, direct evidence suggests that this is the case for the attentional blink (Lunau & Olivers, 2010; Shih, 2000). Thus, the spatially localized nature of emotion-induced blindness suggests that it may stem from mechanisms other than those that drive the attentional blink.

My students and I recently proposed a novel framework positing a "dual-route" impact of emotion on perception (e.g., Most & Wang, 2011; Wang, Kennedy, & Most, 2012). The underlying hypothesis was that emotional stimuli do attract spatial attention to their location, but they at the same time compete with other representations that might be linked to an overlapping point in time and space. This is consistent with notions that rapidly, sequentially presented stimuli can give rise to neural responses that in themselves overlap in time (even though the stimuli themselves do not), and that when such temporally overlapping representations activate spatially overlapping receptive fields in the visual system these representations compete in a "winner takes all" fashion (Keysers & Perrett, 2002). According to this account, emotion-induced blindness occurs because this competition is biased by people's tendency to spontaneously prioritize emotional representations. One key finding that supports this account is the following: we found that when targets and emotional distractors were both embedded in the middle of a rapid stream (as is the case in most emotion-induced blindness experiments), emotion-induced blindness was limited to the location of the distractor. However, when the target was the last item appearing in its stream, this pattern reversed: in this case, target perception was *better* at the location of the emotional distractor, consistent with patterns found elsewhere in the attention-emotion literature (Most & Wang, 2011). This evidence suggests that when the target is the last item in its stream and is not "masked" by subsequent items, its persistence in iconic memory renders it relatively immune to suppression by the emotional distractor because there is less potential to confuse the temporal positions of these stimuli. In this case, it is the more common pattern reflective of *spatial* shifts of attention to the location of an emotional distractor that emerges (i.e., with benefits for target processing at the distractor's location).

COMPETITION BETWEEN TOP-DOWN GOALS AND THE REFLEXIVE DRAW OF EMOTIONS

If emotion-induced blindness arises due to competition between targets and emotional distractors, then it may be possible for certain strategies and task manipulations to strengthen people's ability to prioritize targets, thereby reducing the degree to which emotional stimuli disrupt perception. By the same token, certain contexts or emotional states might bias the competition even more in favor of emotional distractors, thereby increasing emotion-induced blindness. In fact, both of these appear to be the case. For example, in one experiment participants were informed in some blocks that their target could be a rotated picture of either (a) a building or (b) a landscape with no building, and in the remaining blocks they were informed that their rotated target would always be a picture of a building (Most et al., 2005a, Experiment 2). The latter case—labeled the "SPECIFIC ATTENTIONAL SET" condition—enabled participants to establish a more concrete attentional template of what their target would look like, and the results revealed that emotion-induced blindness decreased in this condition, at least among participants who had scored low in a measure associated with trait anxiety. This instruction did not reduce emotion-induced blindness among participants who had scored high in the anxiety-related measure, however, perhaps because for them the bias to prioritize emotional stimuli was more difficult to overcome. Such findings are consistent with suggestions that attention-emotion interactions often depend on the resolution of competition between goal-oriented executive control and reactivity to emotional stimuli, and that individual differences are likely to emerge when these two sources of attentional bias are pitted against each other (e.g., Mathews & Mackintosh, 1998).

In a complementary study, temporary anxiety inductions had the reverse effect, exacerbating the disruptive impact of negative emotional distractors on target perception (Most et al., 2010). In this study, male-female romantic couples visited the lab, and the two members of each couple sat at computers next to each other (with a curtain drawn between them). At the start of the session, a female experimenter stood where both participants could see her and assigned the emotion-induced blindness task to the female participant. The male partner's task, she explained, was to rate the attractiveness of landscapes as they appeared one at a time on his computer screen. The experimenter then left but returned about 10 minutes later to explain that the male partner's task would now change, with the instruction to rate the attractiveness of pictures of single women, many of whom were students at the university (although, in truth, they had no known affiliation with the university). At the end of the experiment, the female partner received a prompt asking her to rate how uneasy she was about the fact that her partner was rating the attractiveness of other women. In two separate experiments, there was a strong correlation between the female partners' reports of unease and the degree of emotion-induced blindness that they experienced during the time that their partner was engaged in this task. Perhaps most strikingly, women who reported themselves as being highly uneasy and those who reported no sense of unease only differed in their performance following emotionally negative distractors, not following neutral distractors or when there were no distractors. Thus, it seems that being in an anxious state may indeed lead people to weight emotionally negative distractors more heavily in the competition for perceptual dominance.

CONCLUSION

Although it may often seem as if the field of perception research lies disconnected from other areas of the field, such as social and clinical psychology, the research reported in this brief review contributes to a growing body suggesting that conscious perception is robustly shaped by the internal states and motivations that often are the focus of these related sub-disciplines. Because conscious perception itself emerges from a complex coordination of mechanisms, an open question is how early in visual processing such internal states exert their regulatory effects. A number of theorists have argued compellingly that early vision is impenetrable by high-level processes such as motivation and emotion (e.g,. Pylyshyn, 1999), and this may yet be the case. The evidence seems clear, though, that when it comes to what we perceptually *experience*, the mind's eye often sees through the filter of the perceiver's heart.

AUTHOR'S NOTE

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10

On the Regulatory Functions of Mood

Affective Influences on Memory, Judgments and Behavior

JOSEPH P. FORGAS

INTRODUCTION

Human beings appear to be a remarkably moody species. Almost everything we think and do is colored by the fluctuating mood states that accompany us. Mostly, moods appear to be a mere disturbance and a source of distraction. Beyond their hedonic influence, moods may also play a regulatory role in guiding our reactions to the manifold challenges of everyday life. However, the functions of affective states and their influence on thinking and behavior remain imperfectly understood (Forgas, 1995, 2002; Forgas & Eich, 2012). Despite centuries of interest, the relationship between feeling and thinking, affect and cognition remains one of the great puzzles about human nature.

Within psychology, movements such as "positive psychology" seek to promote happiness as a cure for many of our individual and societal ills. Even a short visit to any bookshop will confirm that advice on how to be happier, more contented and more satisfied is in great demand. However, within an evolutionary framework (Forgas, Haselton & von Hippel, 2007), we should at least consider the possibility that all affective states, including negative ones could serve an adaptive regulatory function. In this sense, moods may operate like functional "mind modules" triggered by various environmental challenges that spontaneously recruit responses appropriate to the situation (Forgas et al., 2007; Frijda,