this action. For instance, primary motor areas are active in pianists when they hear piano tones but not in novices. Both the functional principle of common coding and the neural evidence for a mirror system define a brand of embodiment that stresses that the ability to perform intentional actions fundamentally shapes people's perception of each other's actions.

Natalie Sebanz and Guenther Knoblich

See also Action and Vision; Body Perception; Direct Perception; Mind and Body; Motion Perception; Multimodal Interactions: Visual–Haptic; Navigation Through Spatial Layout

Further Readings

Churchland, P. S. (1986). *Neurophilosophy: Toward a unified science of the mind brain.* Cambridge: MIT Press.

Clark, A. (1997). *Being there: Putting brain, body and world together again.* Cambridge: MIT Press.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton Mifflin.

Klatzky, R. L., Behrmann, M., & MacWhinney, B. (Eds.). (2008). *Embodiment, ego-space, and action.* Mahwah, NJ: Lawrence Erlbaum.

Knoblich, G., Thornton, I., Grosjean, M., & Shiffrar, M. (Eds.). (2006). *Perception of the human body.* New York: Oxford University Press.

O'Reagan, J. K., & Noe, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences, 24,* 939–1011.

Pfeifer, R., & Bongard, J. C. (2006). *How the body shapes the way we think: A new view of intelligence.* Cambridge: MIT Press.

Schuetz-Bosbach, S., & Prinz, W. (2007). Perceptual resonance: Action-induced modulation of perception. *Trends in Cognitive Sciences, 11,* 349–355.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin and Review, 9,* 625–636.

Emotional Influences on Perception

The effect of emotion on perception has been a topic of interest through much of the history of psychological thought. The notion that what we see is influenced by our internal emotional and motivational states is appealing to those inclined to view aspects of the mind as interconnected even at the earliest information-processing stages. Although accumulated evidence demonstrates that emotion affects the result of perceptual processing—that is, perceptual awareness—questions remain debated and unresolved regarding the precise processing stages at which emotion exerts its influence.

In the 1940s and 1950s, pioneering work by Jerome Bruner and colleagues inspired what became known as the "New Look" movement, a loosely knit effort among psychologists to reveal contributions of emotion, knowledge, personality, and motivation to perception. In one of their classic studies, children were asked to adjust the size of a patch of light so that it matched the size of either various nearby coins or size-matched cardboard disks. The children's errors were greater when estimating the sizes of coins than cardboard disks, a pattern particularly evident among the poorer than more wealthy children. The researchers concluded that perception is influenced by the value accorded to aspects of the environment, and they made the rallying argument that motivational factors need to be considered to understand perception in the real world. Two ideas that emerged from this movement were those of *perceptual defense* and *perceptual vigilance,* which referred to the peculiar manner in which people appeared to exhibit, respectively, impaired or enhanced perception of taboo or emotional stimuli (for example, worse or better recognition of such stimuli, relative to neutral stimuli, in noisy displays). Notably, such ideas—proposed before the maturation of information-processing approaches to perception, which involved differentiation and identification of interacting perceptual stages—seemed to contain within them an insurmountable paradox: How could emotional stimuli gain distinctive perceptual status when the act of prioritizing them necessitated that their emotional significance had already been perceived?

Modern research has at least partly resolved this dilemma, demonstrating that perceptual awareness reflects the output of many processing stages, with contributions from neural regions distributed throughout the brain. Thus, there are many opportunities for the emotional significance of sensory information to be registered before awareness. The amygdala, a neural structure heavily implicated in

emotional processing, appears to receive some sensory inputs that bypass cortical areas associated with attention and awareness—which may explain findings that it responds even to emotional stimuli that people can't report. Furthermore, while this structure receives input from multiple brain areas, it also projects back reciprocally even to early neural processing regions—in the case of vision, as far back as the primary visual cortex. Such feedback connections may be important mechanisms underlying the enhanced activity, as revealed through neuroimaging, in vision-related brain areas in response to emotional, relative to non-emotional, stimuli. For example, emotionally expressive faces have been found to elicit more vigorous activity in a face-selective region of the temporal lobe (i.e., the fusiform face area, or FFA) than do neutral faces, and they have also been found to elicit increased amplitude of event-related potential (ERP) components as early as the P1 component, which peaks a mere 100-ms after stimulus onset. This entry describes the enhanced perception of emotional stimuli, effects of emotion on early perceptual processing, subliminal effects of emotional stimuli, questions about the function of preferential attention to emotional stimuli, and the influence of emotional states.

Enhanced Perception of Emotional Stimuli

Although early research emerging from the New Look movement gave consideration to both enhanced and impaired perception of emotional stimuli, recent work has tended to focus more on the former than the latter. Such work has found that people often are able to perceive emotional stimuli under conditions that would typically render non-emotional stimuli imperceptible. For example, when people search for two targets within a rapidly streaming sequence of stimuli, they often detect the first target at the expense of the second target, an effect known as the *attentional blink;* however, among neurally intact individuals, this effect is diminished when the second target is an emotional word. In other words, the emotional words seem to break through the attentional blink (patients with bilateral amygdala damage, however, show no such benefit for emotional words). Similarly, emotional stimuli tend to predominate over non-emotional stimuli and are perceived more readily during experimental manipulations in which separate inputs to the left and right eyes compete for awareness (e.g., binocular rivalry). Enhanced perception of emotional stimuli is not limited to the visual domain; for example, several experiments have employed "dichotic listening" tasks, in which people attend to auditory information presented to one ear while ignoring auditory information presented to the other ear. Although people often report being unaware of most information presented in the unattended channel, they do tend to notice particularly salient, emotionally meaningful words such as the sound of their own names.

Effects of Emotion on Early Perceptual Processing

In addition to neural evidence, behavioral evidence also suggests that effects of emotion on perception may occur early in the stream of processing. For example, one study found that presentation of an emotional face enhanced *contrast sensitivity* for subsequent targets. This term refers to the threshold of contrast at which people are able to disambiguate a stimulus from the background, and it typically is assumed to be an index of early vision. Although previous research has shown that contrast sensitivity tends to be enhanced via shifts of attention, evidence has also been found suggesting the effects of an emotional stimulus presentation and the effects of spatial attention on contrast sensitivity are additive, raising the possibility that emotion and attention might affect perception somewhat independently of each other. Although speculative, such possibilities converge with findings emerging from the neuroimaging literature: Although the impact of emotion on activity in visual areas can look similar to the impact of attention, some have suggested that the effects might possibly originate from and be instantiated via different neural pathways.

"Subliminal" Effects of Emotional Stimuli

Emotional stimuli tend to attract attention and engage some level of perceptual processing even when participants cannot report them because of laboratory-based manipulations. For example, in one study, high-contrast masks were presented to one eye and intact and scrambled versions of an

erotic picture were presented to the other eye—a manipulation that, because of interocular suppression, leads the masks to dominate and obscure awareness of the pictures. Nevertheless, even though people could not report the presence of an erotic picture, they preferentially attended to its location, as revealed through higher target discrimination accuracy when a subsequent target appeared at the same location as the erotic picture rather than at the location of its scrambled counterpart. In the auditory domain, even when emotionally relevant words escape awareness in dichotic listening tasks, evidence suggests that they are perceptually processed at some level; for example, words that had previously been paired with electric shock—and that thus have some emotional significance—have been found to elicit indices of electrophysiological arousal, even when presented in the unattended stream and when participants report not having been aware of them.

Enhanced Perception as a Function of Preferential Attention to Emotional Stimuli?

Despite behavioral and neural evidence consistent with early effects of emotion on perception, the view that earliest stages of perceptual processing are open to the influence of emotion has been strongly challenged. Indeed, although the emotionality of a stimulus is reflected by activity in early sensory cortices, such findings provide relatively little insight into questions regarding where in the flow of information-processing emotion first exerts its influence. This is because it is difficult to determine whether such effects reflect modulation by emotion at initial processing stages or, instead, reflect "feedback" modulation instantiated via reciprocal projections from areas involved in higher-order processing. Indeed, notions that emotion (or any mechanism outside of a narrowly defined perceptual module) can affect early stages of perception are controversial. Although few would deny that the end product of perception can be colored by emotion, visual perception researchers such as Zenon Pylyshyn have argued forcefully that early stages of perceptual analysis—thought to extract and compute three-dimensional structure in the environment, among other visual tasks—must proceed beyond the influence of higher-order knowledge, expectations, or factors such as emotion and motivation; in other words, they must be cognitively impenetrable. According to this view, effects of emotion on visual processing could stem from effects on attentional allocation (which determines what receives perceptual processing in the first place) and on perceptual judgments and interpretations (which also contribute to our conscious experience), but most aspects of early visual computations lie beyond emotion's bounds. Even early appearing neural signals such as emotion-induced enhancements of the P1 ERP component resemble those that emerge simply as a function of attending versus ignoring a visual stimulus; thus, it could be that emotion influences perception solely through its impact on attention.

Many demonstrations of emotional influences on perception *can* be attributed to effects on attentional allocation. Emotional stimuli often seem to capture attention reflexively, and many of the manipulations that render non-emotional stimuli—but not emotional stimuli—imperceptible involve direct manipulations of attention. For example, the attentional blink described earlier is thought to render targets unreportable by presenting targets closer together in time than can be accommodated by the time it takes to make multiple attentional selections. Also consistent with the notion that emotional stimuli grab attentional resources that support perceptual awareness, the presence of emotional stimuli can actually impair perception of neighboring information: when people monitor a rapid stream of items for a single target, they often fail to detect the target when it is preceded by a particularly emotional distractor.

Influence of Emotional States

Although some research endeavors have focused on the role of emotional stimuli, others have focused on how emotional states influence perceptual processing in general. For example, experiments stemming from what is known as the *broaden-and-build* hypothesis—which suggests that positive emotion widens the scope of attention—have found that inductions of positive mood tend to bias participants to attend to "global" aspects of visual information rather than to "local" aspects: participants who

underwent a positive mood induction showed an increased bias to make matching judgments based on global, rather than local, aspects of stimuli in which the local and global aspects contained conflicting information (e.g., where an assemblage of small squares (local) are arranged to form a larger triangle (global)). Such evidence that emotional states influence perception suggests an important bridge between perception research and clinical psychology, the latter of which focuses heavily on individual differences in chronic emotional states.

Steven B. Most

See also Attention: Covert; Attention: Effect on Perception; Attention and Consciousness; Attention and Emotion; Face Perception; Individual Differences in Perception; Pain: Cognitive and Contextual Influences

Further Readings

Alpers, G. W., & Gerdes, A. B. M. (2007). Here is looking at you: Emotional faces predominate in binocular rivalry. *Emotion, 7,* 495–506.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science, 13,* 34–40.

Jiang, Y., Costello, P., Fang, F., Huang, M., & He, S. (2006). A gender- and sexual orientation-dependent spatial attentional effect of invisible images. *Proceedings of the National Academy of Sciences USA, 103,* 17048–17052.

Most, S. B., Chun, M. M., Widders, D. M., & Zald, D. H. (2005). Attentional rubbernecking: Cognitive control and personality in emotion-induced blindness. *Psychonomic Bulletin & Review, 12,* 654–661.

Phelps, E. A., Ling, S., & Carrasco, M. (2006). Emotion facilitates perception and potentiates the perceptual benefits of attention. *Psychological Science, 17,* 292–299.

Vuilleumeier, P., & Driver, J. (2007). Modulation of visual processing by attention and emotion: Windows on causal interactions between human brain regions. *Philosophical Transactions of the Royal Society B, 362,* 837–855.

Yang, E., Zald, D. H., & Blake, R. (2007). Fearful expressions gain preferential access to awareness during continuous flash suppression. *Emotion, 7,* 882–886.

Event Perception

Event perception is the ability to recognize specific events, to recognize objects in events, and to perceive properties of those objects such as their shape and their weight as well as the specific ways that those objects move. The following is an illustration of event perception: A woman sets out for a walk in the park on a breezy fall day. She is able to see that she is walking and see the world go by as she walks. She can see the trees blowing in the breeze and falling leaves swirling about in the air. Squirrels can be seen leaping among the branches. She sees other people walking or jogging through the park. She sees a child swinging on a swing and another playing hopscotch while a third runs by while bouncing a ball. She sees an elderly man who is lifting a bag that she can see is heavy, so she offers the old man some assistance. All of these acts of perception entail event perception. This entry discusses the beginnings and significance of event perception, auditory and haptic event perception, the problem of information, event segmentation, and mirror neurons and motor theory.

Beginnings and Significance of Event Perception

The study of event perception was begun in 1950 by Gunnar Johannson, who, in his dissertation, actually started two closely related areas of investigation: event perception and structure-from-motion (or SFM). SFM is about seeing objects in events. One can see the rigid three-dimensional (3-D) shape of an object (is it a ball or an egg, a round can or a flat flask?) from seeing the motion of only a few random points on the object's surface. Johansson introduced a technique for isolating patterns of motion as visual information about events and objects in events. He distributed bright dots or patches on the surfaces of moving objects such as a person and filmed them in the dark so that only the dots showed up in the film appearing against a dark black background. When such movies are freeze-framed, so that only any single image from the movie can be seen, it just looks like a random distribution of dots. Without the motion, no three-dimensional structure can be seen. However, as soon as the movie is set in motion, it becomes obvious that it is a person walking.