

First Impressions

Peeking at the Neural Underpinnings

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The chapters in this book provide considerable insight as to the sources of information that contribute to first impressions, the cognitive and mental processes that comprise first impressions, how first impressions affect interpersonal interactions, as well the ways in which we use first impressions in our social world. In this chapter, we examine insights from social and cognitive neuroscience to address the question of the neural underpinnings of first impressions.

We define first impressions as the initial perception and formation of thoughts about another. Our overarching goal is to sketch how the process of forming a first impression occurs at the neural level. We do so in a temporally linear fashion for the sake of simplicity while recognizing that some of the processes we discuss might occur concurrently. We begin with the initial perception of a person, a face, or an object from the environment. Although initial perception can occur by means of input from all five senses, it usually takes place via vision and/or hearing. We then move to the initial, most primitive, subcortical structures (e.g., the amygdala), where this information is first filtered and formed into what

we might consider social thought. From there, we go on to the upper cortex—that part of the brain that most separates us humans from other primates and in which the information takes on a meaning that is truly social. Finally, we end with the processing of this information in the frontal and prefrontal cortices. This is where the information drawn in from the outside world becomes fully processed and crosses the barrier into what we think of as consciousness and the mind. At that point, our impression of another is formed, and this is where we begin to have access to that impression via our conscious thought. At consciousness, the rest of what is discussed in this book begins—our impressions of others and the concomitant, and resultant, behaviors, processes, and complex relationships that color our social world.

SIGHT AND SOUND: THE ORIGINS OF FIRST IMPRESSIONS

The first step in the person perception process begins with perceptions derived from various sensory systems. Although the neural correlates of touch (Deibert, Kraut, Kremen, & Hart, 1999), taste (Norgren, Hajnal, & Mungarndee, 2006), and smell (Shepherd, 2006) have all been explored, arguably the principal senses for perceiving other *people* are sight and sound. Therefore, we consider the starting point of person perception and first impressions to lie within the domains of the visual and auditory cortices, with both human behavior and the neuroimaging research tending to focus on the former (sight) over the latter (sound).

Seeing Others

Explorations of the visual system and person perception have focused on the fusiform face area (FFA). This is an area of the fusiform cortex that appears to respond selectively to faces (though this is debated—see Tarr & Gauthier, 2000). Very few neural structures can boast the sort of specificity demonstrated by the FFA. Despite attempts at domain-specific assignment of behavioral functions to discrete brain regions, none has been as successful as the assignment of face responsiveness to the FFA.

However, person perception can be even better understood when placed in the context of the entire visual system. Our first representation of others occurs in the primary visual cortex (also known as the striate cortex and typically focused on area V1). The visual cortex shows differentiation of objects versus people very early in the perceptual process (e.g., Wang et al., 1999). Signals from the eyes, essentially representing colors, feed to the visual cortex straight to area V1. These

colors are then assembled into patterns and the patterns assembled into shapes. The shapes are then interpreted and sorted for transport out of the striate cortex along two paths. One, the dorsal or “where/how” stream, primarily deals with motion—sending the semirefined visual information in a dorso-cortical direction toward areas in the parietal and temporal cortices, such as the middle temporal and posterior parietal areas (Claeys et al., 2004; Servos, Osu, Santi, & Kawato, 2002; Wang et al., 1999). The other, ventral or “what,” stream primarily deals with objects, body parts, and faces, with such perceptions resulting in the identification of others (Downing, Jiang, Shuman, & Kanwisher, 2001; Herholz et al., 2001; Kanwisher, 2000; Kanwisher, McDermott, & Chun, 1997; Sperling et al., 2001; Wang et al., 1999; but see also Gauthier, Tarr, Anderson, Skudlarski, & Gore, 1999; Tarr & Gauthier, 2000).

On leaving the striate cortex, the first stop along the ventral stream is the extrastriate. The extrastriate contains two areas of particular interest regarding person perception and first impressions. The first of these is the extrastriate body area (EBA; Downing et al., 2001), which deals with the perception of both human and nonhuman body parts (with the exception of the face) and is distinctly sensitive to biological forms. For instance, transcranial magnetic stimulation (TMS) delivered to the EBA causes a temporary lesion to the area that results in the impairment of body part perception while leaving object part perception unaffected (Urgesi, Berlucchi, & Aglioti, 2004). Moreover, unlike higher-order cortical structures that code for the *actions* of body parts, the EBA is preferentially responsive to the perception of *static* aspects of the human form, such as identity (Downing, Peelen, Wiggett, & Tew, 2006; Urgesi, Candidi, Ionta, & Aglioti, 2007). Hence, the EBA plays an important role in perceiving others.

The second extrastriate structure is the fusiform gyrus. The fusiform shows specificity for both perceptual expertise (Tarr & Gauthier, 2000) as well as responsiveness to faces (Kanwisher, 2000), suggesting that humans are expert face processors.¹ Hence, the face-selective area of the fusiform gyrus is known as the fusiform *face* area (see Wojciulik, Kanwisher, & Driver, 1998) and is one of the most important neural structures in the formation of first impressions.

The FFA is most likely the first place in which face stimuli are processed, when faces are intact. When faces are not intact and only parts of faces are perceived, the EBA shows preferential activation (though the EBA does not respond to fully intact faces, thereby distinguishing it in function from the FFA). In addition to the FFA and EBA, an area within the striate cortex also shows activation to face stimuli: the face-responsive occipital region (FROR) within the inferior occipital gyrus. The FROR is

believed to respond prior to the FFA and may possibly serve as a relay station for sending confirmed face stimuli to the FFA for further processing (see Winston, Henson, Fine-Goulden, & Dolan, 2004). The FFA plays an important role in determining the identity of a perceived target. This conclusion comes from research that examines how brain areas differentially respond to spatial frequency information in faces (e.g., Vuilleumier, Armony, Driver, & Dolan, 2003; see Figure 2.1). The term “spatial frequency information” refers to the manner in which gray-scale values change relative to their neighbors within an image. Slowly varying changes in gray scale across an image constitute the low spatial frequencies. Pixel values that vary radically from adjacent pixels in an image make up the high spatial frequencies. High spatial frequencies are important for carrying information about identity, whereas low spatial frequencies are important for carrying information about other qualities of the face, such as emotion. The FFA responds to high spatial frequencies, whereas low spatial frequency information bypasses the FFA and, instead, travels more dorsally to the thalamus (Vuilleumier, Henson, Driver, & Dolan, 2002).

Along the ventral stream of visual information processing, the immediate next stop after the FFA is the amygdala. The amygdala is a structure that is critical for, among other things, the interpretation of socially relevant signals such as affective valence and threat (e.g., Phelps, 2006). Although we will provide a full explanation of the amygdala’s role in first impression formation later in this chapter, for the purposes of the FFA it is important to know that the amygdala and FFA are directly linked. It is supposed that the FFA feeds information about faces and facial identity directly to the amygdala, which then processes the stimulus for cues to threat and/or familiarity (Vuilleumier et al., 2003). Interestingly, the connections between the amygdala and FFA appear to work in both directions: the amygdala receives input from visual areas but also sends information back, influencing visual processing (e.g., Winston, Strange, O’Doherty, & Dolan, 2002; Vuilleumier, Richardson, Armony, Driver, & Dolan, 2004). Indeed, the influence of the amygdala on the visual cortex seems to be greater than the visual cortex’s influence on the amygdala (Iidaka et al., 2001).

Despite the presence of direct links between the FFA and the amygdala, recent evidence suggests that the FFA does not communicate information about emotional expressions directly to the amygdala. Rather, high spatial frequencies are sent forward to the FFA and serve to establish identity, whereas low spatial frequencies take a slight dorsal detour just above the FFA to the thalamus. It is believed that the thalamus recognizes these low spatial frequencies and sends the information directly downward to the amygdala, where the low spatial frequency informa-

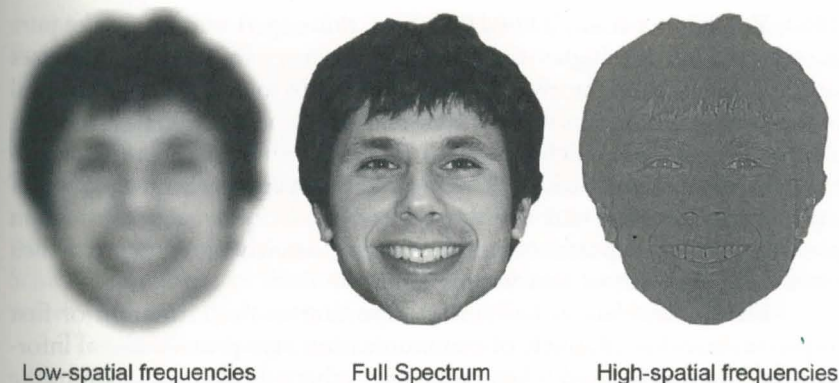


FIGURE 2.1. Visual information about faces is processed in distinct neural areas based on spatial frequency. Low-spatial frequency information (left of center) encodes aspects of the face such as emotional expression. This information is carried to the thalamus and then on to the amygdala. High-spatial frequency information (right of center) contains the features necessary for determining identity. This information is fed from the striate cortex to the fusiform and then to the amygdala.

tion about emotion is integrated with the high spatial frequency information about identity (see Vuilleumier et al., 2003). It has also been suggested that low spatial frequency information from the optic nerve may feed into the thalamus, where it is relayed to the amygdala (see Vuilleumier et al., 2003; Vuilleumier & Pourtois, 2007). This process is thought to occur *prior* to the provision of visual information from the occipital cortex, possibly influencing early visual representations. But the precise timing of these processes is not known, as imaging technology cannot noninvasively track such low-level neuroelectrical activity in these regions.

Although we may tend to assume that our perception of the world is like a camera, feeding directly to our consciousness, growing evidence shows that this is not the case. For example, the concept of “blindsight” refers to patients with damage to visual cortex whose capacity for retino-optical perception is unimpaired. Although these individuals may experience the world as blind, they nonetheless take in visual information from their eyes, which provide input to the brain and cortex (Vuilleumier et al., 2004). Thus, patients with blindsight show activation to threatening stimuli in the amygdala. Although these patients do not report the conscious experience of seeing anything, they show amygdala responses to threatening stimuli similar to the way that individuals with intact visual cortices do (Vuilleumier et al., 2004). Blindsight patients also report fairly accurate intuitive guesses about the physical properties or valence of stimuli (Tong,

2003; Vuilleumier et al., 2004). For them, this experience seems like pure guesswork, but the higher-than-random accuracy rates of such guesses suggest that, despite the absence of processing in the striate cortex, visual information transmitted via this secondary, retino-thalamic pathway can also be passed on to higher-level cortical structures, such as the orbito-frontal and cingulate cortices, allowing for reason and decision making. Insights from blindsight patients regarding nonconscious visual information processing have important implications for intuitive judgments, which often form the basis of first impressions.

Although the face is extremely important in the formation of first impressions, other channels of communication also provide visual information that is processed when perceiving others. Returning again to the striate cortex, particular regions (such as V1, V2, and V3; Servos et al., 2002) are important for the perception of shape and motion. Indeed, biological motion seems to be specially recognized in the brain, and evidence from neuroimaging studies shows that shape and motion cues can be of particular importance in forming impressions about others.

For example, the superior temporal sulcus has been shown to exhibit increased activity in response to human action and in the extraction of information about biological motion (e.g., Beauchamp, Lee, Haxby, & Martin, 2003). Studies in this area use point-light displays to examine biological motion (see Kozlowski & Cutting, 1977). Point-light displays use reflectors attached to the joints of individuals wearing dark clothes while being filmed in a dark room. All that is seen from the person's movement are the points of light as floating dots moving about. At first, the dots appear to be nothing more than an array of scrambled points against a dark background. However, once the individual begins to move, it becomes quickly apparent that the dots represent motion. This movement activates the superior temporal sulcus (STS) and is believed to represent an area especially attuned to social meaning.²

That the STS is involved with social meaning is further supported by the finding that the STS becomes active during experiments involving the inference of thoughts and intentions. Theory of mind refers to the ability to infer the thoughts of others either by taking their perspective and imagining oneself in their shoes ("simulation theory") or by reasoned observation wherein one extrapolates the behaviors of others as might a naive scientist reasoning about a phenomenon ("theory theory"; see Gallagher & Frith, 2003, for a review; see also Chapter 3 in this volume). Since the STS is involved in perceiving biological movement, and because movement is one of the best cues in inferring someone's intentions and thoughts, it makes sense that the STS should be involved in thinking about the intentions of others. Similarly, the STS has been implicated in detecting eye gaze, which also signals intention and focus of

attention (Hoffman & Haxby, 2000; Pelphrey, Viola, & McCarthy, 2004; Pourtois et al., 2004).³

Hearing Others

The tone of voice has been consistently shown in behavioral studies to signal cues to identity (e.g., Gaudio, 1994), emotion (e.g., Johnstone, van Reekum, Oakes, & Davidson, 2006), and intent and thought (see Schiffrin, Tannen, & Hamilton, 2001). Hence, perceptions of others' voices play an important role in forming first impressions, as well.

The social and cognitive neuroscience of vision has received much more attention than the social and cognitive neuroscience of audition, largely owing to the technological limitations of imaging auditory activation in the noisy environment of the fMRI scanner. The studies that have been done have shown some very interesting findings. For instance, emotional prosody (tone of voice), as contrasted with neutral and nonemotional speech, activates the right-middle and superior temporal gyri (see also Grandjean et al., 2005; Mitchell, Elliott, Barry, Crutten-den, & Woodruff, 2003). These activations are distinct from language processing, which typically occurs in the left temporal gyrus. One implication of such studies is that the middle temporal gyrus is active for complex emotional processing, whereas the superior temporal gyrus is active for semantic prosody. Even more importantly, these studies suggest that certain parts of the brain may be especially attuned to particular types of sounds produced by other people.

Sander, Roth, and Scheich (2003) explored how the brain responds to nonverbal vocalizations of laughing and crying. Using a low-noise fMRI scanner, they were able to locate differences between the perception of laughing and crying in the amygdala, insula, and auditory cortex. Activation was greater for laughing in the auditory cortex than for crying, and activation in the amygdala during the control task (detecting pitch shifts in the stimuli) was reported as evidence for amygdala activation independent of the emotional aspects of the stimuli. In another study, Nakamura et al. (2001)—using PET scanning, which does not pose the noise constraints of fMRI—explored how the brain responds differently to familiar versus unfamiliar voices. They found that the left frontal pole and right temporal pole were principally active in response to familiar voices and that activity in these areas was related to memory for voices. Pourtois, de Gelder, Bol, and Crommelinck (2005), also using PET scanning, expanded on this work by demonstrating that combinations of audio (voices) and visual (faces) information activated the left lateral temporal cortex more than either auditory or visual stimuli alone. Similarly, happy voices showed greater activation in middle temporal

gyri and the inferior frontal gyrus than did angry voices (Johnstone et al., 2006).

While the body of research examining how the brain responds to social auditory information may not be as extensive as the literature examining visual stimuli, this work has much to offer to our understanding of the perception of others and the formation of first impressions. Particularly relevant is the implication that the brain is “tuned” to receive and respond to social vocalizations. Such tuning suggests a biological basis for the idea that people form impressions of others from the vocal cues that those others emit.

INTEGRATING IMPRESSIONS AT THE AMYGDALA

We turn now to another level of brain involvement in impression formation: the integration of information at the amygdala. Although the role of the amygdala in impression formation is somewhat debated, most researchers agree that the amygdala is responsive to a range of emotional stimuli, particularly fear (Fitzgerald, Angstadt, Jelsone, Nathan, & Phan, 2006). The amygdala is necessary for both the acquisition as well as the expression of conditioned fear responses (Phelps, 2006). For example, amygdala lesions impair fear recognition, causing unfriendly faces to be perceived as friendly (Adolphs, Baron-Cohen, & Tranel, 2002; Adolphs, Tranel, & Damsio, 1998; see also Ochsner, 2006). The amygdala responds even to subliminal presentations of fearful faces and to eyes expressing fear (Whalen et al., 1998; Whalen et al., 2004).⁴ In addition, heightened amygdala activity has been shown to correspond to higher emotional intensity (Cunningham, Raye, & Johnson, 2004).

Responsiveness in the amygdala across a variety of social tasks has led scientists to ascribe different purposes to the amygdala. For example, some claim that the amygdala is responsive to variations in familiarity, wherein less familiar stimuli (which may be inherently more threatening at first perception) trigger greater amygdala activation (e.g., Whalen et al., 2001). Others, however, have suggested that the amygdala is responsive to changes in the environment (Knight, Smith, Cheng, Stein, & Helmstetter, 2004; LaBar, Crupain, Voyvodic, & McCarthy, 2003; see also Winston et al., 2002). Although we cannot resolve this debate in this chapter, a similar theme that is highly relevant to the formation of first impressions exists among each of these theories. Specifically, fear, familiarity, and stimulus change all appear related to threat and affect. Indeed, as we have noted in our prior discussion of both visual and auditory perceptions, amygdala activation is important in the perception of

threatening and affective stimuli that are important in forming first impressions of others, whether they be faces, bodies, or voices.

The amygdala has also been implicated in judgments of trustworthiness. Winston et al. (2002) have shown that the amygdala bilaterally responds to untrustworthy faces. Although unilateral damage to the amygdala does not disrupt trustworthiness judgments (suggesting that either right or left amygdalae are sufficient to produce responses to untrustworthy faces), damage to the ventral-medial prefrontal cortex (vmPFC), which is projected to by the amygdala, does produce deficits in such judgments. In addition, both explicit and implicit assessments of trustworthiness are associated with orbitofrontal cortex (OFC) activation, presumably because of the connections between the amygdala, the OFC, and the ventral anterior cingulate cortex (vACC; Williams et al., 2006; Winston et al., 2002). Similarly, feedback from the amygdala to hippocampal and visual areas results in increased memory and perception, respectively, for emotionally salient stimuli (Cahill, Uncapher, Kilpatrick, Alkire, & Turner, 2004).

Detecting emotions in other individuals is critical to forming impressions of their mental states, and connection patterns between the amygdala and other brain areas attest to the amygdala's importance in this regard. For example, the amygdala has direct neural projections to the OFC, an area of the frontal cortex that is largely responsible for higher-level emotional processing. The amygdala also has direct connections to the vACC, possibly constituting the final leg of the ventral processing stream that originated in the striate cortex (Cassell & Wright, 1986; Porrino, Crane, & Goldman-Rakic, 1981; Rolls, 2007). One implication of this connection pattern is that information about a target's emotional state may be passed on to higher brain centers even before the striate cortex has completed its visual analysis of the stimulus. As noted earlier in this chapter, information from a target's face may be transmitted rapidly from the amygdala to the vmPFC, possibly by virtue of a retinothalamic pathway that feeds to the amygdala directly from the optic nerve (Vuilleumier et al., 2003; Williams et al., 2006). However, also projecting from the amygdala is a dorsal stream (see Palermo & Rhodes, 2007), which ultimately terminates in the dorsal frontal cortex (dFC; including dorsal ACC), the area most responsible for reasoning and decision making. The fact that the amygdala plays an important role in the communication of emotional stimuli to both OFC and dFC regions fits with the observation that the amygdala is a key player in the formation of impressions of others (Adolphs et al., 1998; Adolphs et al., 2002; Engell, Haxby, & Todorov, 2007; Winston et al., 2004). However, although the amygdala is highly involved in such social inferences and subserves frontal activations, damage to the amygdala does not entirely

eliminate social acuity, suggesting that multiple systems are involved in the process of understanding others (Adolphs, 2006).

Despite the consistent relations of these patterns of brain activation to person perception, there is increasing evidence that individual differences influence neural activation. For example, whereas the amygdala and FFA show decreased activation in response to happy faces among depressed patients, they show increased activation in response to happy faces among healthy controls (Surguladze et al., 2005).⁵ Amygdala activation is also attenuated by participant and target gender such that men show greater left amygdala activation in response to women's faces, whereas women show no difference in the extent to which target gender activates the amygdala in either hemisphere (Fischer et al., 2004). Moreover, women show greater activation in the sublenticular extended amygdala and rostral anterior cingulate cortex (rACC) when viewing negatively valenced versus positively valenced images, whereas men show no difference in activation across image type (Klein et al., 2003; see also Kesler-West et al., 2001). Similar differences are found for amygdala activation involved in emotional memories. Recall of emotionally arousing events increases activation of the left amygdala in women and the right amygdala in men (Cahill et al., 2004). Finally, personality traits, too, may moderate amygdala activation such that extraverted persons show increased activation in the amygdala, caudate, and putamen to positive stimuli whereas neurotic persons show decreased activation to such stimuli (Canli et al., 2001).

GETTING TOGETHER IN THE FRONTAL CORTEX

The frontal cortex serves as the terminus for both dorsal and ventral streams from the amygdala and serves as a final point of integration for information derived from the senses. More specifically, projections from the amygdala ventrally to the OFC are primarily responsible for communicating emotional information, which is then carried superiorly to the rACC. Projections from the amygdala dorsally, however, also terminate in the anterior cingulate cortex (ACC), but in the dorsal areas. From the ACC, information is distributed to areas of the frontal cortex for higher-level thought. The anterior rostral ACC (arACC) is connected to the OFC and reacts to information about the emotional characteristics of a stimulus. The posterior rostral ACC (prACC), however, is the site associated with attention and the monitoring and detection of error. This area is activated when an interruption to continuous processing occurs, such as pain, errors, or the violation of expectations (Adolphs, 2006; Amodio & Frith, 2006). Similarly, the dorsal ACC is implicated in control (Keri, Decety, Roland, &

Gulyas, 2004). Thus, the ACC has primarily been implicated in decision making and the integration of more “rational” cognitive processes with more “irrational” emotional processes (see also Fichtenholtz et al., 2004; Northoff et al., 2004). Similarly, the OFC monitors the outcomes of events, such as rewards and punishments (Amodio & Frith, 2006).

Moreover, although the majority of direct connections are between the amygdala and OFC (at least in terms of emotion), reciprocal paths between the OFC and ventral and dorsal prefrontal cortex (PFC) are also important for emotion regulation (Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003). For instance, activity in the right ventral PFC and the ACC appear to modulate activity in the amygdala, suggesting a feedback control mechanism from such frontally oriented activities as labeling emotional expressions (Hariri et al., 2003). Emotional valence also seems to implicate distinct neural regions, at least for facial expressions. For instance, although all emotional expressions may activate the amygdala, PFC, and FFA, facial expressions of negative emotions appear to activate the right OFC whereas facial expressions of positive emotions appear to activate the right angular gyrus (Iidaka et al., 2001).

Other regions of the frontal cortex also contribute to understanding the neural substrates of first impressions. For example, the dorsal-medial prefrontal cortex (dmPFC), has been shown to be active during judgments of others when one’s own affective experience is necessary to make the evaluation (Gusnard, Akbudak, Shulman, & Raichle, 2001) and for impression formation, generally (Mitchell, Macrae, & Banaji, 2004). Moreover, information that is diagnostic of a target, such as the statement “has a bad temper” paired with a face, activates the dmPFC automatically. However, nondiagnostic information does not automatically activate the dmPFC but only activates the dmPFC if the information is somehow relevant to forming an impression, indicating that the dmPFC is implicated in thinking about others with the goal of forming an impression (Mitchell, Cloutier, Banaji, & Macrae, 2006).

The prACC monitors actions, and the arACC is involved in theory-of-mind tasks. Specifically, thoughts about the self activate the most inferior portion of the arACC, whereas thoughts about others activate the most superior portion of the arACC. Such overlapping activations suggest that we make sense of unfamiliar others cognitively by predicting their actions, yet think about ourselves and similar others emotionally by predicting and estimating their feelings (Amodio & Frith, 2006; see also Mitchell, Macrae, & Banaji, 2006).⁶ Another instance of such delineation within the ACC shows a similar pattern: the caudal ACC is involved in the more cognitive aspects of pain perception, whereas the prACC is involved in the more emotional aspects of pain perception. Hence, the ACC appears to be laid out on a spectrum by which emo-

tional processing is greatest near the border with the OFC and becomes more cognitively oriented as one travels posteriorly toward the PFC.

The ACC is clearly a very important structure for forming first impressions about others. Within milliseconds, information from the sensory organs has traveled through the perceptual cortices, been routed by the amygdala, and is present in the ACC, where thought and consciousness begin to occur. At this final destination for stimulus information, other areas of the prefrontal cortex become active to form thoughts and impressions and to plan actions in regard to perceived others. The area stretching from the ACC forward to the frontal pole (referred to as the paracingulate cortex) is where most of our conscious impression formation of others occurs (Amodio & Frith, 2006). Perhaps the most well-studied part of this area is the medial prefrontal cortex (mPFC). The mPFC may well be the brain region most implicated in social cognition and is largely involved in self-referential thought, self-reflection (Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Mitchell, Mason, Macrae, & Banaji, 2006), and thinking about others (e.g., Ochsner et al., 2004; Seger, Stone, & Keenan, 2004).⁷ This area is implicated both in theory-of-mind tasks, as thoughts about oneself and others are integrated, and has also been found to be active when comparing thoughts about oneself to thoughts about others. However, the anterior rostral portion of the ACC is thought to be the seat of person perception (e.g., Seitz, Nickel, & Azari, 2006). It is in this area that inferences about others are believed to primarily occur.

Information from these areas, though, is not linearly unidirectional. Rather, much as the amygdala feeds back toward the FFA, information within the frontal cortex feeds back to the ACC and then from the ACC back to other structures. One obvious link is that between the STS and ACC, both of which are involved in theory of mind and mentalizing about others. Consistent communication between the amygdala, STS, ACC, FFA, and temporal poles, then, cumulatively gives rise to the way that we are able to form impressions about others (Amodio & Frith, 2006). Note that although we have described this process in a feed-forward manner, originating in the most posterior regions of the brain (striate cortex) and traveling forward to the most anterior regions (prefrontal cortex), the brain is less like a flowchart and more like a roundtable discussion (but see Figure 2.2).

It is this interconnected nature of the brain that explains perhaps the most interesting aspect of first impressions: intuitive judgment.⁸ Although we have already explained how blindsight patients report seeing nothing, though nevertheless possessing knowledge of what it is that their eyes are exposed to, similar processes occur in higher-level cognitive areas (see Tong, 2003). For instance, the OFC responds to both

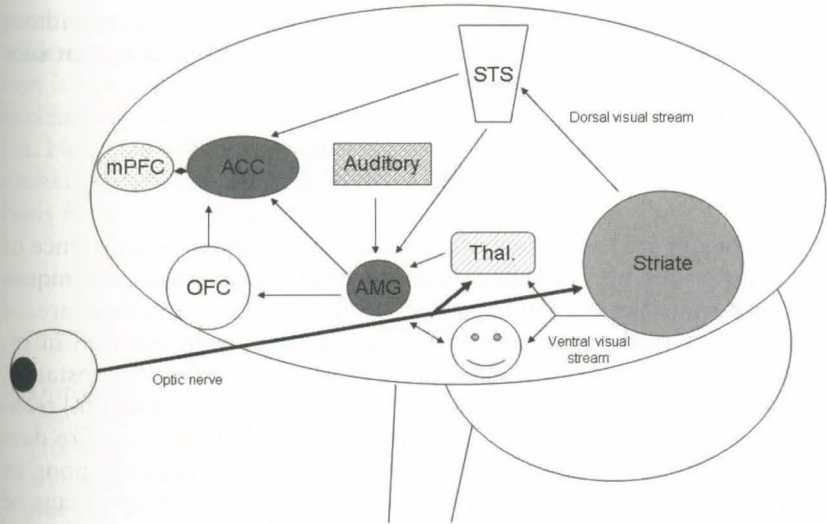


FIGURE 2.2. A conceptual diagram summarizing the formation of first impressions in the brain. Visual information from the optic nerve travels to the striate cortex and also feeds directly to the thalamus. From the striate cortex, visual information travels either dorsally to the superior temporal sulcus (providing information about motion—the “where/how” path) or ventrally to the fusiform face area (FFA) and thalamus. Low spatial frequency information passes from the striate cortex to the thalamus, whereas high spatial frequency information passes from the striate cortex to the FFA. Information from all three regions, and also from the auditory cortex, converges at the amygdala to ascertain the emotional relevance of the stimuli. This information is then projected upward to the orbitofrontal cortex (OFC), medial prefrontal cortex (mPFC), and anterior cingulate cortex (ACC). Information from the superior temporal sulcus (STS) is also passed to the ACC along a dorsal route. That said, each of these connections is believed to be reciprocal—exchanging and refining information—rather than purely feed-forward in character.

blindsight and subliminal presentations of emotional stimuli (Vuilleumier et al., 2002). Promising work by Tong and colleagues has shown that the fixation of someone’s attention to visual stimuli can be read from neuroimaging data of their early visual cortex (striate cortex/V1; Kamitani & Tong, 2005; Meng, Remus, & Tong, 2005; Tong, 2003).⁹ In addition, behaviorally observed phenomena such as the McGurk effect (McGurk & MacDonald, 1976) show that the integration of visual and auditory information can lead to perceptual illusions of which perceivers are not even aware. Hence, much processing occurs outside of consciousness. Indeed, it has been suggested that the *vast majority* of the mind’s activities are outside of consciousness. Much like the blindsight patient whose skin conductance changes in response to the fearful face that he cannot

see, we form our impressions of others and the environment without necessarily having access to all the information and processing that subserves those thoughts (see Vuilleumier et al., 2002).

LOOKING FURTHER

In this chapter we have largely focused on the cognitive neuroscience of first impressions by examining evidence from neuroimaging techniques with high spatial resolution (e.g., fMRI and PET). However, there are, of course, other methods by which one can observe brain function in response to behavioral tasks. Each of these has its benefits. For instance, ERP (evoked reaction potentials) use EEG (electroencephalograph) technology to measure postsynaptic electrical potentials as neurons fire during tasks. While the spatial resolution of ERPs are relatively poor as compared to methods such as fMRI, this method has the advantage of providing fairly good temporal resolution, allowing one to discern “what regions of the cerebral cortex are active when” (see Ito, Urland, Willadsen-Jensen, & Correll, 2006, for a review of ERPs in social neuroscience and person perception).

In addition, lesion studies, such as those providing knowledge of the effects of blindsight, also provide valuable and critical information for understanding neurocognitive function. Again, though contributions from work with patients with lesions and normals with temporary lesions delivered via transcranial magnetic stimulation (TMS) have not been covered extensively in this chapter, they provide unique insights to understanding brain function. Thus, further information about the formation of first impressions may also be gleaned from studies of prosopagnosia, or “split-brain” callosotomy patients, as well as from psychopathological (e.g., Shin et al., 2005) and neurophysiological work (e.g., Harrison, Singer, Rotshtein, Dolan, & Critchley, 2006).

SUMMARY AND CONCLUSION

Throughout this chapter, we have attempted to review the process by which we perceive and form initial thought about others in our social world. Figure 2.2 attempts to provide an illustrative summary of this process; however, it presents only a rough depiction. The current chapter is not an exhaustive review of the literature on cognitive or social neuroscience (see Lieberman, 2007, for a recent review of the field), but it presents a schema for how the brain perceives and forms impressions about others in light of what is contemporarily known. The process of

person perception occurs incredibly rapidly, and once the information feeds forward in the manner we have described, a process of reciprocation is already under way by which the principal areas of the brain begin exchanging and conferring more and more information about the stimulus. Hence, it is the interconnected nature and the mutual and reciprocal exchange of information in our neural structures that forms the neural basis for first impressions.

NOTES

1. Distinctions have been made between the detection of a face and ascribing identity to a face (see de Gelder & Rouw, 2001). For instance, Winston et al. (2004) have shown that the FFA is involved in establishing face identity, whereas other areas (such as the superior temporal sulcus; STS) code for emotion and other changeable aspects of the face that involve movement (see also Henson et al., 2003; Hoffman & Haxby, 2000; Sato, Kochiyama, Yoshikawa, Naito, & Matsumura, 2004). Hence, as face-selective cells appear to exist in areas outside of the FFA—such as the STS, the amygdala, the face-responsive occipital region (FROR), and even the prefrontal cortex—it is believed that these may serve different roles in the perception of faces and the matching of identity and emotion to a face as a visual stimulus. de Gelder and Rouw (2001), however, report that the FROR within the inferior occipital gyrus is the structure responsible for simple face detection.
2. Notably, STS activation is stronger for videos than for the more impoverished point-light displays. The medial temporal area appears to be involved in motion processing, whereas biological motion activates the area anterior and superior to the medial temporal gyrus—namely, the STS—and videos and point-light displays of nonbiological movement activate the medial temporal area and the area just below it in the inferior temporal sulcus (ITS; see Beauchamp et al., 2003).
3. STS response to eyes appears to be automatic. When participants see a stimulus that can be manipulated to look like a pair of eyes versus the wheels of a car, the STS is active only when the phenomenon is perceived as eyes. Participants' reflexive orienting to the image (a measure of attention), however, does not differ (Kingstone, Tipper, Ristic, & Ngan, 2004).
4. Adams, Gordon, Baird, Ambady, and Kleck (2003) offer an alternative explanation. In their work, they found an interaction between eye gaze and facial expression for amygdala activity. They argue that, ecologically, fear is an aversion-related response and anger is an approach-related response. Similarly, averted eye gaze signals aversive intentions, while direct eye gaze signals intentions to approach. Therefore, by combining fear and anger expressions with averted and direct eye gaze, they concluded that left amygdala activation is greater for ambiguously threatening expressions, that is, anger with averted gaze and fear with direct gaze. Noting this, they point to a possible confound

- in the earlier work on fear in the amygdala, as most or all of the previous studies have used fear faces with direct eye gaze, which is ambiguously threatening. Therefore, the reason that the amygdala responds differentially to fear versus anger may be due to a difference in the nature of the signals: congruent (anger with direct gaze) versus incongruent (fear with direct gaze).
5. Notably, the amygdala and FFA of depressed patients also show an increased response to sad faces.
 6. Kaplan, Freedman, and Iacoboni (2007) even found mPFC activation for participants' favored political candidate prior to a U.S. presidential election, reflecting identification of the favored candidate with the self.
 7. Mason, Banfield, and Macrae (2004) asked participants to imagine actions if performed by a dog or by a person. They found that thinking about humans activated areas within the PFC (e.g., mPFC, ACC) but that thinking about dogs activated occipital regions. Hence, we appear to reason about human actions using the frontal cortex, whereas visualizing nonhuman (dog) actions results in occipital activation. This is not the case if thinking about the dog's mental state, though—then the mPFC is used for both the dog and the human (Mitchell, Banaji, & Macrae, 2005).
 8. Leube, Erb, Grodd, Bertels, and Kircher, (2003) have suggested that the intuitive feeling of familiarity involves the dorsal visual stream, as contrasted with the ventral visual stream, which processes identity—for example, the sense that someone seems familiar without being able to recognize who the person is, or the opposite phenomenon (the Capgras delusion), in which individuals can identify a face but do not feel that it is a familiar one.
 9. Similarly, Ress and Heeger (2003) have shown that activation in the visual cortex is greater for misses than for false alarms in a signal-detection paradigm, indicating that early visual processing corresponds to *perceived* rather than physically presented (purely visual) stimuli.

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