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The Social Dance

On-Line Body Perception in the Context of Others

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Perception of Others Is Inherently Social

Humans have evolved to act in the world—to do things. Further, many of the most important and complicated things we do, from passing the cream for the coffee at the breakfast table to surviving a cocktail party, we do in the context of interacting with others. As social animals, one of the key issues to be resolved by each individual is how to operate in the context of other humans. Our perceptions of others help us, for example, to cooperatively work with others for successful adaptation to the environment, mate, negotiate social hierarchy, detect cheaters, and enhance our group's status and resources.

Overview

In this chapter, we take an embodied approach to social perception, emphasizing that interacting with other people is much more complicated than interacting with unmoving, inanimate objects.

Human perceptual systems are evolved to capitalize on the functional importance of perceiving others as people and understanding what they are going to do next. We make the case that the key to reducing these perceptual and cognitive complexities is the creation of self-other correspondences between the perceiver and the person viewed via the use of specialized body processing mechanisms. Specifically, we argue that our own bodies help us organize information from others. We combine research on body perception with research on embodied emotional perception and suggest that these specialized body processing mechanisms may be fundamental perceptual mechanisms on which social-emotional processes are based. Further, disruption of these mechanisms may lead to social-emotional deficits such as those observed in autism.

The Importance of Social Perception

Essential to functioning in a social environment is the accurate perception of others. To do so, people use verbal and nonverbal information, the latter including facial, vocal, and postural behaviors. It is obvious that humans communicate through facial expressions, and the majority of research has focused on the role of faces in social perception and communication. Unfortunately, the very salience of faces has caused researchers to deemphasize a perhaps more primal method of social perception, namely body posture recognition. Without denying the significance of the face, we focus here on the body as an example of more general person perception. Others' body postures give us information about who they are, what they are doing, what they intend to do, and, most significant to us, whether and how we should respond to what they are doing.

There is substantial evidence that body postures have meaning to humans and other animals. Consider the male gorilla display of pounding the chest or similar human displays on the football field. Animals integrate visual, movement, and postural information for the purpose of environmental assessment (especially risk assessment) and the determination of subsequent action (Blanchard, Blanchard, & Hori, 1988). For example, fish use postures to communicate dominance and territory (e.g., Desjardins, Hazelden, Van der Kraak, & Balshine, 2006; Martin & Redka, 2006) as do other animals that do not have the facial musculature to use facial expression (Blanchard,

Blanchard, Rogers, & Weiss, 1990). In addition, animals' neural systems support posture discrimination in other animals. Single-cell extracellular recordings from sheep's temporal cortical neurons indicate preferential neural responses to bipedal human postures that disappear when humans adopted quadrupedal postures, when human body parts alone were presented, or when human faces were presented (Kendrick & Baldwin, 1989). Thus, body posture processing appears to be a basic mechanism in animals. This importance of body posture processing across species suggests that humans may have evolved specialized processing for this function.

Proponents of embodied cognition emphasize that the body acts in the world. Here we argue that embodied cognition must also emphasize that the body acts and reacts in a *social* world. Indeed, the centrality of the group and of collective action to humans suggests that effective social functioning is fundamental to individual and species success. Thus, the existence and influence of specialized body-based processes and representations on perception have even greater relevance if they are used in the context of perceiving others. These processes are most relevant to social interaction when they occur in real time, so that we know what others are currently doing and feeling—and so we know how to respond appropriately. The importance of fast and accurate body posture recognition makes it likely that people possess specialized processes for coordinating perceptions of ourselves and others. Thus, social perception emphasizes the need for body-specific representations and processes to organize information from the self and others in the service of social action.

The Added Complexities of Social Perception for Embodied Cognition

For over a century, researchers have acknowledged that our bodies play a critical role in our cognitive development, functional capabilities, and emotions (Darwin, 1889; Gibson, 1977; James, 1884; Piaget, 1954). Theories of embodied cognition emphasize the importance of sensorimotor experience and the interaction of the body in the world (cf., Harnad, 1990). Human cognition, including social-emotional perception, has sensorimotor roots. Human's current cognitive capacities evolved from those of our primal ancestors whose neural resources were dedicated primarily to motor and perceptual

processing because immediate, on-line interactions with the environment were most relevant for survival (Wilson, 2002). Developmentally, as human infants learn to control their own movements and perform certain actions, they develop an understanding of their own basic perceptual and motor-based abilities, which provide the fundamental bases for acquiring more complex cognitive processes (Piaget, 1954; Thelen, 1995; Thelan & Smith, 1994). According to this view, cognition depends on the kinds of experiences that come from having a body with particular perceptual and motor capacities that are inseparably linked. Such bodily experiences in the form of affordances, knowledge, and goals combine to create the basis for memory, emotion, language, and all other aspects of life (Glenberg, 1997). These previous sensorimotor experiences are reinstated and simulated to aid and constrain abstract thought (Barsalou, 2002, 2003; Glenberg, 1997; Glenberg & Kaschak, 2002).

Theories of embodied cognition also emphasize the importance of the context in which actions take place. Nonetheless, it is important to consider the goal of the activity and the objects at which bodily actions are directed (Moore, 2006). If an organism actively constructs a sensorimotor representation based on a set of environmental features relevant to the action it is performing, that same environmental space is perceived differently if the goal of the action changed, thereby changing the relative salience of different features. For instance, a chair would be perceived differently if one's goal was to put books on the chair or to sit in it.

However, when bodily actions are considered within the context of other people, the agency and the intentionality of the other person necessarily changes processing by adding self-other relationships. Planning actions to affect a chair for sitting is fundamentally less complex than planning action to affect a chair of a department. Others' intentions and ability to perform their own actions increase the processing loads and constraints relevant to our own actions in the environment. It is not merely that an object moves. It is the *agency* of another person that increases the number of potential environmental changes exponentially and necessitates efficient, on-line, real-time processing. Not only do social interactions require one to assess the current state of the other person, they also require one to predict what the other person might do and plan how to respond. Moreover, the social object of perception changes in response to each of our actions, both adding information as to their intent, and necessitating

changes in our own reactions. The timing of these social actions and reactions is essential for the seamless, fluid communication that is observed in typical interactions between people. The apparent ease of this complex interpersonal dance makes it almost invisible, until one sees the functional consequences for those individuals who are unable to automatically join the dance. Indeed, it appears to be this kind of real-time prediction-action-reaction “dance” that individuals with social deficits such as autism are unable to do.

Thus, successful social interaction requires an enormous amount of information about the intentional relations of the self and other to be processed. This is a significant challenge for the comprehension of the nature of human social understanding and theory of mind (Barresi & Moore, 1996). Our cognitive systems must have developed an efficient way for self-other correspondence to be constructed. One way to establish the commonalities between the self and other may be through processes attuned to human body structure and biomechanics (Wilson & Knoblich, 2005; Wilson, 2001, 2005). In this chapter, we examine how body-specific representations and processes organize information from the self and others and how they play a significant role in social-emotional perception.

Body Perception: Creating Self-Other Correspondences

The prioritization of perceptual processing associated with conspecifics is clearly evident in humans. Other humans capture attention and elicit complex behaviors (Downing, Bray, Rogers, & Childs, 2004; Ro, Russell, & LaVie, 2001). Slaughter and Heron (2004) have summarized research documenting that from early on, infants react to humans differently from the way that they react to other multifaceted, attention-grabbing stimuli: infants move and vocalize differently to people and objects (Legerstee, 1991, 1994; Legerstee, Pomerleau, Malcuit, & Feider, 1987; Trevarthan, 1979, 1993); infants favor human faces and voices relative to other stimuli (Fantz, 1963; Johnson & Morton, 1991; Kuhl, 1987); infants are able to recognize and identify specific people before they can distinguish specific non-human objects (Bonatti, Frot, Zangl, & Mehler, 2002; Field, Cohen, Garcia, & Greenberg, 1984); and infants categorize humans and other objects differentially (Quinn & Eimas, 1998). Empirical evidence supports the idea that infants treat other humans as “special.”

Thus, developing perceptual systems appear to be primed for “like my species” information.

Much of social perception requires an assessment of how much “like me” another person may be. Although person perception is more complex than object perception, we also are equipped with unique templates to use in this task. Unlike the majority of objects that we encounter in our lives, visually perceived body postures, actions, and facial expressions of other people can be mapped onto and reproduced by our own body and face. We can identify other humans, as humans, because they possess both a human face and a human body that are similar to ours and that can make similar expressions, postures, and movements.

Research in body perception, in particular, emphasizes the importance of self-other correspondences in the perception of others. Structural similarity between the self and other provides information regarding commonalities in spatial layout. It also permits inferences regarding the body’s biomechanics with which one can determine whether one’s own body could perform similar movements (Rizzolatti & Craighero, 2004; Wilson, 2001). Recent evidence suggests that the brain provides a special status to perceptual stimuli that correspond to one’s own body (Blakemore, 2006; Downing, Yuhong, Shuman, & Kanwisher, 2001; Grossman, 2006; Saxe, 2006). The similarities between another person’s body and our own permit multimodal inputs from both bodies to be represented in a common representation.

Specialized Body Representations

At the core of self-other mapping, there must be a representation of the body that contains the basic spatial layout and biomechanics of the human body to help organize perceptual inputs of other bodies and objects. Developmental, behavioral, and neuropsychological studies have all provided evidence for a long-term spatial representation specific to the body.¹ This representation of the body specifies the relations among the body parts. It is shown to be spatially organized, supramodal, and used for representing other bodies as well as one’s own (Buxbaum & Coslett, 2001; Gallagher, 2005; Reed, 2002; Reed & Farah, 1995; Schwoebel, Buxbaum, & Coslett, 2004). The adult neuropsychological literature provides additional evidence for a long-term

spatial representation of the body that is unique from other object representations. Patients with autopathognosia cannot locate body parts on themselves or others despite demonstrating knowledge of bodies, naming of body parts, and relatively intact spatial abilities (DeRenzi & Scotti, 1970; Ogden, 1985). Deficits in spatial body representations are also not limited to the visual modality in some patients. One patient was unable to locate his body parts by touch or by vision (Ogden, 1985).

Developmental researchers have investigated what aspects of human faces and bodies allow infants to distinguish them from other objects. For faces, the relative location of facial features appears to be important. Infants within the first few months show a strong preference for stimuli that resemble human faces over comparably complex, high-contrast patterns (see Maurer, 1985 for a review). Young infants prefer to look at typical faces with the features in their canonical positions relative to scrambled faces with the features in noncanonical positions (Johnson & Morton, 1991). Given that preferences for human facial patterns exist at birth, it seems likely that the newborn visual system is somehow tuned, either by an innate template or a perceptual bias for high-contrast top-bounded patterns, to recognize, track, and fixate on facelike patterns (Johnson, 1997; Johnson & Morton, 1991; Turati, Simion, Milani, & Umiltà, 2002; Valenza, Simion, Macchi Cassia, & Umiltà, 1996).

A sensitivity to human bodies also appears early in development. Some evidence from phantom limb patients points to the existence of primitive spatial body representation that may be hard-wired in the brain (but see Price, 2002 for a discussion). Despite a lack of sensory input and experience using limbs, individuals with aplasia (i.e., born without limbs) often experience phantom limb sensations (Weinstein & Sersen, 1961) and perceive movements of other people's limbs no differently from typically developing individuals (Funk, Shiffrar, & Brugger, 2005). In typically developing children, a sensitivity to the *configuration* of body parts appears sometime after the first year of life. Slaughter and colleagues (Slaughter & Heron, 2004; Slaughter, Heron, & Sim, 2002) showed typical and scrambled human body and face images to infants between the ages of 12 and 18 months. Based on looking preference measures, infants younger than 18 months of age clearly distinguished between typical and scrambled images of faces but not bodies. However, by 18 months of age infants could discriminate typical from scrambled bodies. Although infants'

perceptual expectations about typical human faces develop earlier than those about human bodies, it is clear that a human body template is shared among infants.

During the first year of life, infants also acquire a sensitivity, or a template, for the biomechanics of how humans move and the organization of the human body (Fox & McDaniel, 1982; see Pinto, 2005 for a review). Three-month-old infants prefer point-light walker displays of upright walking humans relative to inverted walking humans (Fox & McDaniel, 1982). By 5 months of age they are able to distinguish global form as long as it provides a context in which the features are salient. Pinto (2005) argues that infants' visual sensitivity to the structure of the human body corresponds with the infants' acquisition of a basic set of motor skills during the first 18 months.

Thus, sensitivity for human bodies combines visual perception and motor production. Researchers have proposed that infants use a supramodal body scheme to integrate and process stimuli across sensory modalities and specifically across vision and proprioception. In a number of experiments, newborns demonstrate an ability to copy gestures including mouth opening, tongue protrusion, and lip protrusion when adults model those gestures (e.g., Abravanel & DeYong, 1991; Meltzoff & Moore, 1977, 1983, 1989, 1992, 1995, 1997). One study also reports that neonates can imitate sequential finger movements (Meltzoff & Moore, 1977). The ability of infants to view another person's movements and reproduce them with their own bodies indicates that infants have a representational system of the body that links the actions of the self (proprioception) to the actions of another (vision) via supramodal or cross-modal integration (Meltzoff & Moore, 1995).

Using One's Own Body to Organize Information From Others

Across the life-span, the activation of a multimodal spatial body representation contributes to the development of self-other relationships. Beyond early development, though, how do one's own body actions contribute to the understanding of others? To address the question of whether we use our own body representations to interpret the actions of others, researchers have examined how our own postures and actions change our visual perception of other people's postures and actions. For example, in Reed and Farah (1995), par-

ticipants were asked to view and compare two sequentially presented postures of another person. Participants were also asked to move their limbs while performing the comparative task. Performance in the posture memory task depended on participant movement. If participants moved their arms, their memory for other people's arm postures was selectively improved. When participants moved their legs, their memory for other people's leg postures selectively improved. Importantly, the interaction between body movement and memory was specific to the body. When the primary memory task was changed to remembering the positions of upper and lower regions of an abstract object, movement had no effect on memory. Further, these facilitatory effects could not be attributed to imitation. When participants matched one part of their body to the remembered position and moved the other part, body part memory selectively improved for the moving parts, not the imitating parts. A follow-up study (Reed & McGoldrick, 2007) confirmed that participant movement was also critical. No effect was found if participants watched another move. Thus, it appears that the same body representation is used to encode the body positions for the self and others. Our own bodies selectively affect how we perceive the bodies of others.

Specialized Body Processing

The fact that what we do with our own bodies influences the perceptions of other people's bodies suggests that there is something distinctive about the way we view the human body. Do humans have specialized processing mechanisms for recognizing the body postures of others? Previous research has compared the perception of the human body to inanimate objects (Heptulla-Chatterjee, Freyd, & Shiffrar, 1996; Shiffrar, 2006; Shiffrar & Freyd, 1990, 1993). However, human bodies differ from inanimate objects along a number of dimensions, including shape, rigidness, movement characteristics, and intentionality (Shiffrar, 2006). Animate objects may be a much better comparison group and human faces may be the best (Slaughter, Stone, & Reed, 2004). Humans can configure their faces and body postures into positions that convey emotions, intentions, and other meaningful information. Given that faces and bodies are usually attached, there are good reasons to believe that there are similarities in face and body perception. Both are important social stimuli

for which recognition has evolutionary importance. Both are viewed extensively from birth (Slaughter & Heron, 2004). Both are identified at subordinate categorical levels (Tanaka & Gauthier, 1997).

Reed and colleagues (McGoldrick & Reed, 2007; Reed, Stone, Grubb, & McGoldrick, 2006a; Reed, Stone, & McGoldrick, 2006b; Reed, Stone, Bozova, & Tanaka, 2003) have investigated similarities and differences in the way that bodies and faces are perceived. Many researchers have argued that the perception of faces is “special” because, unlike other objects, it depends on configural processing (e.g., Maurer, Le Grand, & Mondloch, 2002). In other words, one cannot distinguish two typical faces on the presence or absence of their parts. Instead, one needs precise metric information about the shape and distance among the features. A similar argument can be made for distinguishing between two body postures. Researchers argue that configural processing develops for fast and accurate fine level distinctions within an object class (Tanaka & Gauthier, 1997). As a result, Reed and colleagues investigated whether configural processing was also used for body postures.

To think about specialized processes used for human body perception, it helps to consider the configural processing continuum (e.g., Reed et al., 2006a, b). At one end of the continuum, objects (e.g., houses) are recognized on the basis of their parts, largely independent of where they are located or in what orientation the object is situated. However, at the other end of the continuum, objects (e.g., faces) are recognized holistically by templates in which parts are not explicitly represented (Tanaka & Farah, 1993). Thus, faces have been proposed to be recognized by a different perceptual mechanism than most other objects. The recognition of faces requires the relative spatial relationship among the features as well as their individual shapes and metric distances from each other. Faces are also different from other objects in that they are highly sensitive to orientation. It is much more difficult to recognize faces upside down than upright. The question is whether human body postures are more like houses or more like faces.

One of the most widely used empirical indicators of configural processing is the face inversion effect (Yin, 1969): the recognition of upright faces is faster and more accurate than inverted faces. Inversion disrupts the spatial relations among features. To investigate whether configural processing was used for body posture recognition, Reed and colleagues (Reed et al., 2003; Reed et al., 2006a) used a typical inversion paradigm (see Figure 3.1). Participants viewed two





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FOCUS ON CROSS (250 MS)	SEE PICTURE #1 (250 MS)	BLANK SCREEN (1000 MS)	SEE PICTURE #2 IS IT SAME OR DIFFERENT?
+			
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Figure 3.1 A typical body inversion paradigm. The viewer is presented with two stimuli presented sequentially and determines whether the two stimuli are the same or different postures. Stimuli are either presented in upright (top) or inverted (bottom) positions. The correct response to both example trials is “different.”

sequentially presented stimuli in the same orientation (i.e., either both upright or both inverted); they determined if the two stimuli were the same or different. When the recognition of abstract (i.e., meaningless) body postures were compared to houses, strong inversion effects were found for bodies but not houses. To determine whether body postures were more like faces, faces and body postures were evaluated. Comparable, strong inversion effects were found for both faces and body postures (Reed, Stone et al., 2003). These results suggest that both faces and bodies are processed configurally. Additional evidence for the configural processing of bodies was provided by Stekelenburg and de Gelder’s (2004) EEG study in which they demonstrated that the N170 component, a component that has been associated with the configural processing of faces, was relatively enhanced and delayed by inverted bodies compared to upright bodies.

Once it was determined that body postures were recognized by configural mechanisms, Reed and colleagues used this information to determine what body information defined a human body. To find out what body information was necessary for the visual system to treat the body as a body, they examined what body stimulus manipulations lead to the breakdown of configural processing and loss of the inversion effect (Reed et al., 2006a). After replicating the

body inversion effect for whole bodies, they then eliminated and manipulated the body stimulus. When half bodies were tested in which bodies were divided along the vertical axis, dividing left from right, the inversion effect was maintained. It appears that the visual system was able to reconstruct the body from the long-term body representation because the body is largely symmetrical along its vertical axis. Then half bodies were tested in which the bodies were divided at the waist, along the horizontal axis. It was possible that the body inversion effect was largely derived from head, trunk, and arm positions because that portion of the body provided the greatest amount of variation in posture. However, the inversion effect was lost for both upper and lower portions of the body. When examining body parts such as the arms in which local configural information could be used, no inversion effects were found. Of interest, however, was that both upright and inverted body parts were highly discriminable. Last, when body parts were scrambled within the context of the body (i.e., arms put in the head position, legs in arms, etc.), no inversion effect was found and discriminability among postures was exceptionally low. When limbs are placed on the trunk in locations where they are not supposed to be, not only does the visual system not treat the stimulus as a body, but also its ability to discriminate plummets. When the spatial locations of limbs on the trunk violate the spatial body representation, body posture perception is impaired.

Thus, the way we view the human body is distinct from most other objects. Like faces, bodies show inversion effects but houses do not. This suggests that the configuration of body parts is important for recognition. Until now, faces were the primary class of objects to consistently produce a significant inversion effect for the untrained, average viewer. These findings suggest that a different mechanism is used to recognize human body postures from inanimate objects such as houses. Last, the body appears to be defined by its hierarchical structure. Configural processing appears to interact with the spatial body representation for posture recognition.

Sources of Specialized Body Processing

Another question is where does this specialized processing of the human body come from? Some researchers have claimed that configural processing is really the result of expertise and that because we

interact with other humans with their faces and body postures that we have a lot of expertise in recognizing other people. We are experts in face and body posture recognition. Is it possible that expertise from having a body can influence body perception? By investigating body perception, two possible sources of expertise can be examined, visual expertise and embodiment expertise (Reed, Nyberg, & Grubb, 2007). *Visual* expertise suggests that sufficient experience viewing a particular class of objects can lead to a shift from parts-based recognition to configural recognition (e.g., Tanaka & Gauthier, 1997). For example, Diamond and Carey (1986) found the inversion effect in dog show judges to be much larger for breeds in their domain of expertise as compared to other breeds. Gauthier and Tarr (1997) demonstrated that trained individuals could demonstrate configural processing for the recognition of “greebles,” a novel object class, that untrained individuals recognized by their parts.

Another source of expertise, *embodiment*, comes from having a body and knowing how to use it. In other words, motor, proprioceptive, and kinesthetic experiences associated with living in a body and knowing how it works can influence our visual perception. To investigate these two types of expertise, Reed and colleagues (Reed et al., 2007) had participants discriminate common and rare postures of people and dogs using a typical inversion paradigm. These participants were average viewers with no exceptional expertise in dog training or dog show judging. Dogs were selected as comparison stimuli because they are animate and are some of the most frequently seen animals in our everyday lives. Our intent was to equate viewing frequency with humans as much as possible. Based on pretesting that determined ratings of typicality for postures that were most human and most doglike, the highest-rated postures for humans and dogs were used. The postures that were most typical for humans were also rated least typical for dogs and vice versa. Rare stimuli were created by placing humans in the dog postures and dogs in the human postures.

This crossing of animal by viewing frequency led to different predictions for the two types of expertise. For visual expertise, greater configural processing was expected for humans than for dogs because humans see more humans. Also, effects of frequency were expected for both humans and dogs in that there should be greater inversion effects for common objects because common objects are viewed more frequently than rare objects. For embodied expertise, greater

configural processing was expected for humans than for dogs but for a different reason, namely that humans have more experience interacting in a human body. Further, effects of viewing frequency were expected only for dogs because humans know how to get into all biomechanically possible postures. For dog postures, the close mapping between what humans do and the rare dog stimuli could permit embodiment expertise to be applied to the recognition of those non-human stimuli. The only postures in this group that humans cannot map their own bodies onto were common dog postures.

Results confirmed greater inversion effects for human compared to dog stimuli. Viewing frequency did not influence the robust inversion effects found for human postures: For accuracy data, comparable inversion effects were found for both common and rare human postures. However, viewing frequency did influence inversion effects for dog postures. Only rare dog postures produced an inversion effect. These rare postures of dogs in human positions depicted postures for which the mapping of the observer's body was easily made to the dog's body. This pattern of results supports the idea that embodiment expertise contributes to visual body processing. Thus, both embodiment expertise and visual expertise contribute to the configural processing of bodies. This conclusion is consistent with data from biological motion studies in which observers most accurately can recognize movement from their own bodies, but they are better at recognizing the movements of friends than strangers (Loula, Prasad, Harber, & Shiffrar, 2005). Also, it is consistent with other findings that demonstrate graded body-specific perceptual effects as the stimulus perceived grows increasingly different from the human body configuration (Cohen, 2002). Configural processing mechanisms used for recognition in our own domains of expertise can be co-opted when people use their own body representations to interpret the visual world.

Summary

Humans are embodied and optimized for processing “like me” information. Perceptual processes integrate information about the observer's own body and others' bodies. Processing changes if stimulus features resemble information in the observer's own body representation. Specialized body representations and mechanisms

permit processing efficiencies to help organize information from other people's bodies.

What good are these mechanisms? The significance of interpersonal action suggests that a key function of these mechanisms is social perception. People's perceptual goals are functionally based around what other people are currently doing; knowing what another is about to do increases the chances that one's own actions will be appropriate.

Because emotions involve response-coordination packages (Atkinson & Adolph, 2005; Panksepp, 1998), knowing the emotional state of others is a critical and effective way to understand and predict their actions. For example, after returning a midterm exam, faculty do well to distinguish among an angry student approaching versus a sad or frightened one—and to distinguish this quickly and without waiting for verbal signals. The general importance of such situations suggests that social-emotional perception is an obvious place to look for the role of the embodied processes. Thus, we next discuss how these specialized body-perception processes influence emotional perception.

Emotional Body Perception

When on the subway, dating, or giving a job talk, two of the most important things to know about relevant others are whether they are feeling positively or negatively, and what they are likely to do next. Moreover, a group that can quickly and accurately transmit emotional information among its members has a collective survival advantage. For example, a prairie dog will express fear by drawing attention to itself by means of sounding an alarm, thus allowing the others in its prairie dog community to dive underground. Given the adaptive importance of knowing others' emotional states, we focus here on how the aforementioned body-specific mechanisms can facilitate the processing of interpersonal emotional stimuli. This functional approach to social perception provides an explanation for why we might have specialized representations, processes, and neural networks for helping us perform the function of what we should do next. Theory of mind, emotional contagion, social-emotional perception all contribute to tell us about what others are going to do, and how we should respond to their actions.

Perceiving and interpreting other people's emotional states is critical for effective social interaction. Emotions are widely regarded as evolutionary adaptations. They evoke behaviors that improve an animal's chances for survival and procreation in that they enable animals to cope with threats and opportunities presented to them by their physical and social environments (Atkinson & Adolph, 2005; Lazarus, 1991). The production and perception of emotional signals (Darwin, 1872/1998) may have evolved as response-coordination packages to meet particular environmental challenges such as avoiding physical harm (fear) and contaminants (disgust) (Atkinson & Adolph, 2005; Panksepp, 1998). In social interactions, the necessity of processing speed and the generation of specific behaviors makes specialized cognitive and neural systems beneficial for the processing of certain socially and emotionally relevant information. Given that the perception of intentional agents adds significantly to perceptual processing loads, it would make sense to co-opt specialized body representations and processes in the service of social perception, especially when facial expressions and body postures provide relevant information.

Understanding Others through One's Own Facial Expressions and Body Postures

Understanding the actions, intentions, and emotions of others is vital for social functioning. There are undoubtedly multiple processes that underlie such knowledge of others; nonetheless, facial expressions and body postures appear to be basic sources of insight into the emotions and intentions of others (Hatfield, Cacioppo, & Rapson, 1994). It is common that people must interpret the meaning of a social interaction from the subtle nuances of a facial expression or body gesture. We often acquire information about the internal emotional states of others from the slump of the shoulders or the tilt of a head. These are subtle facial and body posture cues that most people perceive quite naturally, without effort. The ease with which we are able to understand these cues and match our own bodies to others displaying these cues suggests that we have specialized processes assisting the correspondence between perceived emotions and bodily configurations in ourselves and others. As described in the previous section, knowledge of one's own body may assist in

this process by providing a cross-modal template upon which one can come to understand others (Meltzoff & Moore, 1995). Further, our own actions can influence how readily we are able to perceive another body configuration (Reed & Farah, 1995; Reed & McGoldrick, 2007).

The recognition of another person's emotion is undeniably an important factor in the perception of others. A large body of research has documented that facial expressions can unambiguously convey certain emotions such as happiness, sadness, fear, anger, and disgust. More recently, body postures have been shown to unambiguously convey emotions such as pride (Tracy & Robins, 2004) and touch has been shown to unambiguously convey emotions such as sympathy or love (Hertenstein, Keltner, App, Buleit, & Jaskolka, 2006). It is also important to be able to tell the subtle differences in body posture between emotional and nonemotional actions. Recognizing whether someone is reaching over their head to strike you or to scratch behind an ear could be critical for survival. Discerning these subtle nuances of body position or action is something that people tend to do well from static body postures or even with degraded information. For example, people can easily distinguish the emotional tone of movements in point-light displays (Atkinson, Dittrich, Gemmel, & Young, 2004).

Correspondences between one's own body and the body of another are likely to play a role in our understanding of their emotional state. There appear to be rapid, automatic processes that lead to matching the facial expressions, vocal tones, postures, and movements of others (Hatfield et al., 1994; Moody & McIntosh, 2006). This mirroring or mimicry of others may provide means by which we use our own body and face to gain information about another person. Although, as evident above, much of the research on self-other correspondences has focused on the body, the majority of research on mimicry has focused on facial expressions. Despite the relative emphasis on the face, the processes described below are likely to be the same for the body; work that includes the body suggests that this assumed similarity is accurate.

A number of studies together diagram a process by which mimicry can influence our knowledge of other's emotions. Mimicry is theorized to lead to emotional contagion, when one person's emotion generates a similar emotion in an observer (Hatfield et al., 1994; McIntosh, 2006; McIntosh, Druckman, & Zajonc, 1994). The

matched facial or bodily position or movement may cause internal feedback that can create a change in a felt emotional experience: If you smile, you feel happier, and if you slump, you feel sadder (Dulcos, Laird, Schneider, Sexter, Stern, & Van Lighten, 1989; McIntosh, 1996; Riskind, 1984). Because facial expressions can initiate or modify emotional feelings in a person (see reviews of the facial feedback hypothesis by Adelman & Zajonc, 1989; McIntosh, 1996), a mimetic assumption of another's emotional facial expression, posture, or vocal tone may in turn cause the observer to feel what the observed person is feeling.

Facial postures can induce emotional states even when the manipulation is not an emotional one. For example, after participants repeatedly utter sounds that place the facial muscles in a scowl ("ü") or a smile ("ee"), their mood changes to match the analogous expression (McIntosh, Zajonc, Vig, & Emerick, 1997). In addition, when participants put pens in their teeth creating a partial smile or put their pens in their lips creating a partial frown, the facial postures induced the corresponding emotional states within the participants (Berkowitz & Troccoli, 1990; Ohira & Kurono, 1993; Larsen, Kasimatis, & Frey, 1992; Strack, Stepper, & Martin, 1988). Furthermore, the facial postures also influenced participants' emotional assessments of visual stimuli. For example, cartoons were judged to be more amusing when the pen was in the teeth relative to the lips.

That the effect of facial movement on affective experience is relevant in true interpersonal situations has been demonstrated by McIntosh (2006). Observers watching others' natural, spontaneous emotional responses to positive and negative videos mimicked their facial expressions, and the observer's own emotions changed in association with the models' emotions. That people mimic live, dynamic facial expressions supports the naturalistic importance of mimicry. Further, this process appears directly relevant to social understanding, as mimicry influences the perception and interpretation of others' facial expressions of emotion (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001).

Building on the research demonstrating the importance of facial action on emotion, researchers have shown that body postures also influence one's subjective experience of emotion (Dulcos et al., 1989; Riskind, 1984; Stepper & Strack, 1993). Individuals induced to assume postures characteristic of certain emotions reported feelings that corresponded to those postures (Dulcos et al., 1989). For example, indi-

viduals who slumped tended to feel sad while those who sat more forward with a clenched fist tended to feel anger (Dulcos et al., 1989).

One's own emotional state may then allow for a greater understanding of the other person via a shared emotional experience. Part of this shared emotional experience appears to come from self-other correspondences facilitated by body-specific processing. Further, the emotional quality of body postures may also alter the perceived relationship between oneself and others even when the task has nothing to do with emotional assessment. Wilbarger, Reed, and McIntosh (2007) investigated whether the perception of another's posture was influenced by an interaction between the emotional quality of one's own posture and a model's posture. Participants assumed a posture as per the experimenter's instructions, maintained the posture for several seconds, and then resumed a neutral position (i.e., legs together, arms at side). They then viewed a model in a posture and determined whether the model's posture was different from the one they had just assumed. Postures were affectively positive, affectively negative, abstract/meaningless postures, and meaningful but not emotional. Results indicated a clear difference between emotional and nonemotional postures, whether they were meaningful or not. When participant's own postures *matched* the viewed postures, participants were selectively impaired in the speed and accuracy with which they recognized emotional postures.

One explanation for this pattern of results is that the assumption of emotional body postures automatically activates tightly defined emotional categories and states specific to that person. The specificity of the observer's own emotional bodily experience may create a more specific criterion for judging the viewed posture of another as the "same." Thus, self-other correspondences do not only aid social perception by emphasizing similarities between the self and others, but they also help to distinguish fine level differences that helps to maintain one's own emotional state within a social context.

Deficits in Understanding Others: Autism.

We have argued that social perception is facilitated by the perceiver matching the movements, postures, and facial expressions of others. Support for the importance of self-other correspondences can be found by examining the effects of breakdowns in this process. Below

we demonstrate that these specialized face and body processing mechanisms are essential components of typical social-emotional functioning through deficits in social perception for people with autism. In other words, autism provides a window into these mechanisms because individuals with autism produce outcomes that would be expected if these mechanisms were disrupted.

Some people appear not to perceive or respond typically to the social milieu. Deficits in social perception are associated with difficulties in social adjustment. In fact, a hallmark of autism is an apparent lack of awareness and perception of other people's emotions and social contexts. In a their review of the autism literature, Volkmer, Chawarska, and Klin (2005) conclude that the research points to the existence of fundamental deficits in the earliest social processes in autism, with disturbances of affective contact which then influence many other areas of development. We believe that this impaired social perception may, in part, be a result of deficits in basic face and body processing mechanisms that create self-other correspondences. If physically matching the emotional facial or postural position of another is critical to understanding their emotions, then one would predict that those who do not or cannot match others would have difficulty in emotional perception. Indeed, this is the pattern we see among people with autism.

Recent evidence shows that people with autism do not quickly and automatically mimic emotional expressions. Typically developing people automatically, unintentionally, and quickly match the movements of an observed model (Dimberg, 1982; Dimberg, Thunberg, & Elmehed, 2000). When adolescents and adults with autism were shown emotional facial expressions, however, electromyography showed that they did not display the mimicry seen in a comparison group matched on age, gender, and verbal intelligence (McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006). Neither group had difficulties matching facial expressions of others when they were asked to do so. These data indicate that people with autism have a specific deficit in the automatic matching of emotional facial expressions. Such a deficit would be predicted to impair the experience of self-other correspondences, alter their perception of others, and impair understanding of others' emotional states.

Just as predicted by an embodied approach to social-emotional perception, people with autism do not perceive others in a typical manner. Most generally, autism has been associated with atypical face

and configural processing, as indicated by the lack of a face inversion effect (i.e., upright faces are recognized better than inverted faces) (Dawson, Webb, & McPartland, 2005; Hobson, Ouston, & Lee, 1988; Langdell, 1978). Significantly, this impairment is not limited to facial perception, but is also evident in body perception. Reed, Beall, Stone, Kopelioff, Pulham, and Hepburn (2006) found that high-functioning individuals with autism were insensitive to other people's body postures. They used an inversion paradigm that compared the recognition of upright and inverted faces, body postures, and houses. In contrast to typically developing adults who demonstrated inversion effects for both faces and body postures, adults with autism demonstrated only a face inversion effect. Because these adults were high-functioning and had all participated in social skills classes that emphasized face awareness, these adults with autism may have acquired face recognition expertise, albeit atypically, that could be used for configural face processing. However, this face expertise was not used for body posture processing.

This difficulty in perceiving others has consequences for social-emotional perception in people with autism. Consistent with the above findings, they appear to focus on individual facial features rather than configurations when perceiving emotional expressions. Rutherford and McIntosh (2007) found that individuals with autism use facial features in a rule-based approach of emotional perception, rather than the template-based strategy used by typically developing people. Participants were shown pairs of stylized color face images of anger, disgust, happiness, fear, sadness, and surprise. They were asked to indicate which of two faces expressing a single emotion that varied in intensity were most realistic depictions of the specified emotion. For all but surprise, those with autism were more likely to accept the most exaggerated images as most realistic. These extremely exaggerated faces were created by quadrupling the average displacements of six facial features for typical expressions of these emotions, based on pretesting and norming. Because rule-based strategies are more tolerant of extreme stimuli than are template-based ones, this is the pattern that would be expected if people with autism do not automatically learn to read the emotions of others, but instead have learned explicit rules to decipher others' emotions. We believe that the absence of the self as a referent may require the use of explicit rules in judging expressions, and thus make perception of others' emotional states less automatic and less

connected to one's own experiences, leading to errors or inefficiencies in such perception.

This rule-based approach is likely to be slower than the configural, template-based processes we argue are critical for smooth social interactions. Evidence for the predicted impairment in quickly extracting emotional information from other is provided by Fazenheiro, Winkielman, and McIntosh (2007). When stimuli were presented very quickly, people with autism were specifically impaired in the ability to accurately determine the emotional valence of facial expressions, but were similar to typically developing and reading disabled controls in their ability to extract major nonaffective features (e.g., gender) from faces or to distinguish between nonaffective and nonfacial stimuli. These data support the notion that individuals with autism have a specific impairment in early extraction of emotion—just what would be predicted if automatic processes are impaired in this group.

Because of the importance of quickly perceiving others' emotions during dynamic social encounters, our line of thought would predict that people with autism should have difficulty in perceiving emotion from movement. Indeed, they appear to be impaired in the assessment of dynamic emotional cues from bodily action. Hobson and colleagues (Hobson, 1995; Moore, Hobson, & Lee, 1997) found that typical, as well as developmentally delayed, adults, adolescents, and children could accurately describe the emotion conveyed in point-light displays, but individuals with autism who demonstrate deficits in emotion processing had more difficulty with the task (Ozonoff, Pennington, & Rogers, 1990).

Thus, unlike typically developing individuals for whom specialized face and body processing develops naturally, individuals with autism appear to lack the predisposition for these specialized processing mechanisms. As a result, they are missing a fundamental component of social perception. Most strikingly, this deficit appears to affect their ability to engage in real-time social interactions that require the precise timing of responses to others' social cues.

Conclusions and Future Directions

The introduction of specialized body processing mechanisms as an essential part of emotional processing adds to our understanding of

social perception. The idea that emotional perception is embodied is not new. However, what is new is our emphasis on the fundamental perceptual processes from which embodied emotional processes derive. Social psychologists are embracing the tenets of embodied cognition as a means to explain how we understand the emotions of others. They emphasize how the reinstatement of previous sensorimotor experience during emotional and social information processing is an essential process for understanding others' emotions (Neidenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Further, they propose that our bodily states that arise during social information processing, or our own simulation of emotional events, provide insights into another person's emotional states. We argue that these models of embodied emotion are currently missing the necessary body-processing mechanisms from which the simulations of emotional experience operate; a full understanding of social-emotional perception requires incorporation of such mechanisms. If one cannot create the basic correspondences between another person's body and one's own, such as what may be found in autism, then one cannot engage in the appropriate simulation process that leads to emotional understanding.

Our integration of body perception and social perception literatures also points to some future directions for research in face perception. Theories of body perception often link the importance of perception and action and emphasize the correspondences between the self and others. In contrast, these ideas are often implicit or not addressed at all in theories of face perception and emotion. Given the value of self-other correspondences for social perception, a promising line of research would be to take a more functional approach to the actions that facial expressions perform in social contexts. Specifically, studies of face and body perception should explicitly investigate whether self-other correspondence leads to faster more accurate processing of emotions as well as a better understanding of what the other person is feeling or is likely to do next. Similarly, given that the basic processes of self-other correspondence and body perception are likely to be altered by the purpose and context in which the perception is taking place, research on the basic mechanisms should expand to investigating such influences. It is only by putting the mechanisms within the contexts in which they function that we can gain a more dynamic understanding of how social perception operates.

In conclusion, humans have bodies that perform important actions in the world. Other humans are also acting in the world and toward each other, which adds to the complexity of the perceptual processing necessary to figure out what one should do next. We never need on-line body specific processing more than when we dealing with social stimuli. Social interactions are similar to waltzing—one anticipates the placement of a partner's foot for the placement of one's own, a partner's push on the hand leads to the give of one's own and together the social dance turns.

To meet these social needs, specialized representations, processes, and neural networks have evolved to permit fast and accurate calculations that allow us to know what comes next. Perhaps more importantly, they help us coordinate social interactions. One of the primary purposes of embodied perceptual processes is to facilitate our functioning in dyads or groups, whether it involves sharing a limited resource, establishing an alliance, learning the actions of the group, or communication rituals. There is increasing evidence that some of these specialized body mechanisms, including body posture recognition, face recognition, and emotional recognition, are part of what appears to be a larger neural network optimized for social information (Blakemore, 2006; Grossman, 2006; Saxe, 2006, Haxby, Hoffman, & Gobbini, 2000). We are just beginning to understand how perceptual embodied processes interact with the communication and understanding of other people's emotions and other evolutionarily important functions.

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Note

1. In the body perception literature, the terms *body schema*, and *body image* have both been used to refer to the long-term, body-specific spatial representation. Both have also been used to refer to the on-line

immediate body representation. Given this confusion, these terms will not be used in this chapter. Instead we will refer to long-term spatial body representations.

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