CHAPTER 4

EMBODIMENT OF COGNITION AND EMOTION

Piotr Winkielman, Paula Niedenthal, Joseph Wielgosz, Jiska Eelen, and Liam C. Kavanagh

In recent years, embodiment theories have become a major conceptual framework for understanding the mind, including the social mind (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Schubert & Semin, 2009). The idea of embodiment theories is that higher level processing is grounded in the organism's sensory and motor experiences; hence, such frameworks are often called grounded cognition theories (Barsalou, 2008; Wilson, 2002). According to embodiment theories, processing of information about, for example, tools, flavors, melodies, driving directions, emotional faces, social and personality characteristics, and even abstract social, moral, emotional, or motivational concepts, along with many other kinds of information, is influenced, informed, associated with, and sometimes dependent on perceptual, somatosensory, and motor resources. In this chapter, we illustrate advances in the power of this account of how information processing works and discuss where new limits and challenges are being revealed.

The structure of the chapter is roughly as follows. We begin by contrasting embodiment theories with their main competitors—theories that emphasize the amodal, propositional nature of mental representations. We then review some evidence for embodied processing in more cognitive domains. We then move on to a detailed description of research on embodied processing's role in emotional perception and emotional language comprehension, the role of embodied metaphor in understanding interpersonal relations and morality, and the role of mimicry in social judgment. Finally, we discuss the applicability of embodiment theory to understanding and perhaps helping to ameliorate impairments of social functioning, using autism and depression as two illustrative examples. We conclude with the suggestion that a fully fleshed-out embodied account of information processing is still a work in progress. It may in fact be the case that the embodiment perspective cannot satisfactorily account for some important aspect of cognition and emotion. Still, the embodiment perspective has proved remarkably generative in terms of both producing new findings and explaining major phenomena and is likely to continue being a major force in psychology in general and social psychology in particular.

THE TRADITIONAL VIEW: AMODAL PROCESSING

The human conceptual system supports many cognitive operations, from the recognition of a single object to complex decision making. The major models of the conceptual system within cognitive psychology have traditionally been associative network models (e.g., Anderson, 1983). According to this view, when perceiving an entity, such as a member of one's family, information is initially encoded in the brain's modality systems, such as the visual, auditory, and probably affective systems. The information is then extracted into an abstract language-like symbol (a proposition) and stored as a node. In the associative network view, the node might be the word *brother*. This symbol or node is stored in some relation to other information that represent features

http://dx.doi.org/10.1037/14341-004
APA Handbook of Personality and Social Psychology: Vol. 1. Attitudes and Social Cognition, M. Mikulincer and P. R. Shaver (Editors-in-Chief)

such as loud, funny, and athletic. These features were again initially encoded in the brain's modality systems but now represent conceptual nodes. Later, when thinking about one's brother, what is extracted from memory and used to make inferences are (at least) these pieces of information in their languagelike form, that is, a label for the concept and a list of its features.

Thus, in associative network models, nodes arbitrarily stand for units of information. Nodes are further interconnected by associative links, though this term is slightly misleading because links can be structured, or labeled, representing a type of relationship, such as property (*has*), inheritance (*is part of*), and so forth. In any case, the patterns of links among nodes represent concepts. When a node is activated, the nodes that are associated with it are activated as a function of the strength of association via spreading activation. The more a node is interconnected, the greater the probability that it will be activated by its neighbors. Ideas already stored in memory influence online processing to the extent that they are activated. The full set of nodes or units of information in the associate network constitutes a person's conceptual system. The conceptual system in theory then provides structure and content for processes such as inference, categorization, memory, and other operations of higher cognition.

Note, however, that adopting the associative network system as a model for understanding how the human mind works involves accepting two explicit assumptions. One is that the activities of the mind are unconstrained by the specific structure of the body and the brain—a central tenet of functionalism (Block, 1995). A second, more specific but related assumption is that higher level cognitive processes operate on abstract, nonperceptual symbols. That is, to become the subject of thought, information that is initially encoded in the perceptual system (e.g., vision, audition) must be extracted, transduced, redescribed, and stored in an amodal (i.e., modality-free) way (Fodor, 1975; Pylyshyn, 1984). Recent advances in cognitive science have cast doubt on both assumptions, and departing from them is therefore considered a productive idea (Barsalou, 2008). We discuss the findings that this departure has produced in the next several sections.

EMBODIED PERSPECTIVE

On a general level, theories of embodied cognition hold that information processing is shaped by the specific form of the human nervous system and body and its interactions with the external, physical world (Barsalou, 1999; Clark, 1999; Wilson, 2002). A reoccurring theme emerging from accounts motivated by this perspective is that thinking (offline processing) involves partial reproduction or simulation of experiential and motor states that occur when the perceiver has actually encountered the object (Barsalou, 1999, 2008). For example, when trying to perform a recall task—say, describing one's favorite colleague to a friend—one recalls traces of direct perceptual experiences with that colleague, perhaps using them to mimic his or her movements or reconstruct the sound of his or her voice. More important, an embodiment perspective applies particularly well to thinking about emotion (Niedenthal, 2007; Niedenthal et al., 2005; Winkielman, Niedenthal, & Oberman, 2008). Most people are aware that when they cogitate on some joyful personal moment, they also partially reproduce the joyful state. Critically, embodiment theories hold that, far from being incidental, such reenactment is sometimes crucial to reasoning, using emotional concepts, mindreading, and interpreting language (e.g., understanding the difference between joy and happiness). It is important to note that this reenactment—called *embodied simulation*—does not have to be a conscious, full-blown physical episode. Instead, simulation involves reinstantiating enough of the original experience to be useful in conceptual processing. As we discuss later, such simulations do not simply result from associative connections between concepts and somatic states. Instead, they are constructive reenactments produced when it is necessary to represent this conceptual content in information processing.

EVIDENCE FOR EMBODIMENT FROM THE NONEMOTIONAL DOMAINS

Convergent evidence from different experimental paradigms has caused embodiment theories to be taken seriously as an alternative to the amodal view of cognition. In this section, we review experiments and paradigms from cognitive psychology and cognitive neuroscience that seem to support an embodiment approach.

Perhaps the most researched area to date is the involvement of sensory modalities in the comprehension and production of conceptual information. One paradigm for testing the role of sensory modalities in conceptualization is the property verification task. In this task, participants are asked to verify or deny that a certain object has a certain property (i.e., answer a question such as "Do cats have wings?"). Results here show that speed of property verification—a conceptual task—is related to the perceptual salience of the feature in question (Solomon & Barsalou, 2004). For example, properties that are larger are verified more rapidly, presumably because they are easier to see on a recalled or simulated visual representation.

Another task, feature generation, involves the production of lists of features for a particular object. Here, research has shown that specific features of a particular object (i.e., the visual or auditory features) vary as a function of presumably irrelevant perceptual variables (L. L. Wu & Barsalou, 2009). For example, when participants listed the features of the concept *half watermelon,* they were more likely to spontaneously produce the features *seeds* and *red* than when they had to list the features of the concept *watermelon.* Presumably, the interior visual features of the watermelon were revealed in simulating the former concept and not the latter. These findings extend also to novel concepts such as *glass car* (as opposed to *car*). This finding is important because it shows that the patterns of performance could not be purely the result of stored associations between amodal propositions and thus cannot be fully explained via simple associative priming.

Several classic embodiment studies focused on the phenomenon of switching costs when changing modalities in which conceptual information is presented, mirroring previous findings in perception. Perception researchers have shown that when attention shifts from one modality to another (switching from audition to vision, e.g.), the second stimulus is processed more slowly than it would have been had the two stimuli both used the same modality, implying a time cost to switching modalities (e.g., Spence, Nicholls, & Driver, 2001). Pecher, Zeelenberg, and Barsalou (2004) reasoned that, if conceptual processing also takes place in sensory modalities, then a switching cost should also be found for conceptual processing. This cost was demonstrated in a series of experiments that showed that participants verified features of a concept in one modality more slowly if they had just verified a feature from another (vs. the same) modality—for example, *BOMB–loud* followed by *LEMON–tart* (vs. *LEAVES–rustle*). The reasoning is that, if a just-used modality is appropriate for the processing of the next concept, then it should already be online or activated when the next concept is processed, so one might expect the next concept to be processed more quickly. Crucially, switching-cost results of this type are difficult to interpret as simple priming. First, the critical property pairs (e.g., *loud–rustle*) were not associated in the Nelson, McEvoy, and Schreiber (1999) norms. Second, additional experimentation with highly lexically associated pairs showed that, compared with the modality-switching effect, the associative priming effects from property words are minimal (Pecher et al., 2004).

Another well-known set of findings from the grounded cognition literature focused on the interaction of high-order sentence processing with perception and action. These experiments showed that participants' speed of object recognition increases when the images are consistent with the particular visualization implied by a sentence that they have just read. In one study (Stanfield & Zwaan, 2001), investigators constructed sentences that were identical except for one critical word or phrase that influenced the spatial orientation of a particular object. For example, the sentence *The carpenter hammered the nail into the floor/wall* could cue participants to simulate the viewing of a nail in a vertical or horizontal orientation, respectively. After reading each sentence, participants saw an image and indicated whether the object had been mentioned in the sentence. Critical trials were all positive trials. Two images were used for all such objects, each one corresponding to a simulation of one version of the sentence (e.g., pictures of horizontal or vertically oriented nails). Results showed that participants responded faster to targets that had perceptual properties that were consistent with a visualization of the just-presented sentence. A similar study used sentence pairs that would cause the same item to be differently shaped during simulations. For example, the sentence *The Ranger saw an Eagle in {the sky/its nest}* was followed on a critical trial by either the image of a perched eagle or of a flying eagle (Zwaan, Stanfield, & Yaxley, 2002). The results again showed that simulation-consistent images were recognized more quickly.

An objection to the embodiment interpretation is that the sentences in these studies were parsed via semantic networks and that the networks' end states effectively primed some images more than others during subsequent verification tasks. An individual could have several images of an eagle in memory, and perhaps images of eagles in flight were primed more by the processing of the words *eagle* and *sky*. This argument, however, could not be extended to account for the results of related studies, such as Horton and Rapp's (2003) demonstration that objects described as being occluded from view in a sentence were recognized more slowly than those described as being seen. Equally difficult to account for is Yaxley and Zwaan's finding (2007) that when participants read sentences describing objects as hazy or viewed through blurry goggles, low-resolution (blurry) images of those objects were recognized more quickly than when the same objects were described as being seen clearly. As predicted, the reverse was true for objects described as clearly seen. These results are exactly what one would expect if participants were visually simulating the content of sentences.

These just-mentioned studies are representative of cognitive psychology findings supporting embodied cognition in the nonemotional domain. However, there are many others, and the reader is invited to consult some classic papers and reviews (Barsalou, 2008; Gallese & Metzinger, 2003; Glenberg & Kaschak, 2002; Pecher, Zeelenberg, & Barsalou, 2003; for a review of the embodiment of linguistic meaning, see also Gibbs, 2003).

Evidence for embodiment is also found in the literature on cognitive neuroscience. Embodiment theory predicts that modality-specific areas of the brain such as the auditory and visual cortices should be involved when verifying or generating properties that pertain to the given modality. This idea has been investigated via experiments that wed neuroimaging to standard cognitive psychology paradigms. Kan, Barsalou, Solomon, Minor, and Thompson-Schill (2003) found that brain areas involved in a certain perceptual modality (i.e., visual cortex, gustatory cortex, or auditory cortex) were activated during verification of conceptual properties that refer to the same modality (e.g., verifying that *BOMB–loud* activated auditory cortex). Patterns of brain activation during feature generation yield similar results (Simmons, Hamann, Harenski, Hu, & Barsalou, 2008). If tasks such as these were indeed performed using amodal mechanisms, one would expect very similar patterns of activation no matter what modality is used to actually perceive a feature.

An intriguing line of recent evidence for embodiment of conceptual processing comes from brain imaging studies comparing right-handed and left-handed individuals. Participants showed increased activation in the brain hemisphere contralateral to their dominant hand when imagining actions such as grasping or cutting, which are usually performed with the dominant hand, but not when imagining actions whose actual performance did not involve the hands, such as kneel (Willems, Toni, Hagoort, & Casasanto, 2009). One might object that this result only shows that action planning, not processing of conceptual meaning, activates embodied processing. However, these activation patterns held when participants were asked simply to read words representing actions performed with the dominant hand without being asked to imagine the action (Willems, Toni, Hagoort, & Casasanto, 2010). A further objection could be that this result is due to simple, associative links between language and motor resources that have no causal role in conceptual processing. However, when theta-burst repetitive transcranial magnetic stimulation was used to disrupt activity in motor planning areas corresponding to participants' dominant hands, participants' ability to distinguish manual action verbs from pseudowords was impaired, suggesting a causal role of the motor resources. Disruption of premotor areas controlling the nondominant hand had no effects, and neither type of disruption had any effect on the ability to process words referring to actions that are performed without the use of the dominant hand (Willems, Labruna, D'Esposito, Ivry, & Casasanto, 2011).

Is There Any Amodal Processing?

Significant differences exist between embodiment theorists regarding the prevalence and relative importance of embodied processing in people's cognitive life. Some authors believe that much of people's mental life is modality based (e.g., Gibbs, 2003). However, in the view of others (including us), the traditional description of cognition is accurate for some cases. Certainly people's conceptual skills allow them to construct representations that are not slaves to their perceptual instantiations (Caramazza & Mahon, 2006). For example, people understand the essential, functional features of the number three regardless of whether it is written as *3, III,* or *three.* In fact, more than 4 decades ago Piaget (1965) insightfully described how young children abstract the concept of number. They can do it from simply observing that, for example, the sum of individual objects remains the same regardless of whether, say, the individual pebbles are small or big, are blue or red, are spread apart or placed close together, are counted from left or right, or are arranged in a line or a circle. Similarly, one can think about how to solve a storage problem using the abstract idea of a container without having to mentally commit to its particular size, color, or shape. Of course, these representations might always have a concrete component, and people often use external tools (fingers, blackboards, iPads) to help with symbolic operations, but the point is that people understand that the concretization is not essential to the symbolic content, and they can easily abstract from it in their thought process (e.g., 2 + III = five). In another, more social example, many legal concepts, such as copyright, eminent domain, liability, culpability, or negligence are essentially nonperceptual, even though they may often be learned, and later explained to others, using perceptual metaphors.

Also, features of many abstract concepts are represented by such strong or rich semantic and associative links that accessing a perceptual trace memory, or constructing a perceptual simulation, is unnecessary. For example, people do not need to construct perceptual number representations when doing basic mental arithmetic ($6 \times 6 = 36$). Nor do people need to retrieve perceptual trace memories of a bull to verify that it can be grabbed by its horns. Finally, as discussed later, even in the emotion domain people can sometimes answer difficult questions about emotions without necessarily simulating their concrete, perceptual instances. For example, when asked about the difference between anger and guilt, it is people's conceptual, not perceptual, knowledge of emotion that allows them to say that anger involves another person's fault and that guilt involves their own fault.

One hypothesis initially offered by Piaget (1965) and then developed by Jean Mandler (2008) is that perceptual simulation may be prevalent in the early stages of development, when abstract reasoning is underdeveloped, and that embodied processing may be progressively replaced by more abstract, domain-general reasoning. The same logic may also apply to adult cognition. Thus, novel concepts are initially grounded in an embodied metaphor. However, if a metaphor is reused often enough, and the results of its use can be represented well by a semantic network, then semantic processing will be an efficient shortcut, eliminating the need for simulation. Data consistent with this logic have recently been reported by Desai, Binder, Conant, Mano, and Seidenberg (2011). They examined neural correlates of processing expressions such as "grasp an idea" and found that such metaphors activate corresponding sensorimotor brain areas only if they are relatively unfamiliar.

Perceptual simulation may be most useful and therefore most likely to occur when either no preexisting semantic associations exist (e.g., to the concept of *glass car*) or those associations are relatively weak or ambiguous. This is not unlike mental imagery, which is most useful if there is no easy way of reasoning to the answer. For example, the reader may want to answer the following question: "When you enter your office from the outside, is the door handle on the left or right?" We expect that the reader used perceptual or motor simulation only when this question was novel or difficult (Kosslyn, 1994).

Finally, the use of a particular embodied simulation also depends on the specific situated conceptualization or the context in which the concept is being processed (Barsalou, 2003). For example, if the conceptual task does not require generation of internal properties, then they are not simulated (L. L. Wu & Barsalou, 2009).

Conditionality and Context Dependency of Action Simulation

Let us now further develop the point about the conditionality of simulation processes by turning to the classic domain of embodiment research—action understanding. In fact, perhaps the best behavioral and neuropsychological evidence for mental simulation comes from studying the role of the perceiver's motor processes in perception and reasoning about action-related objects. In general, behavioral studies have found that people are quicker to respond to a question about an object or an action if the action implied by the question is compatible with the action of responding to the object. For example, research by Glenberg and Kaschak (2002) and by Tucker and Ellis (1998) showed that individuals reason about sentences that describe actions more efficiently if they are currently making the same actions themselves. Consistent with behavioral findings, neuroimaging studies have also shown that the left ventral premotor cortex, which is involved in performing actions, is activated when naming tools (Chao & Martin, 2000). Together such studies have indicated that motor simulation accompanies visual and conceptual processing and can possibly facilitate the understanding of sentences, words, and pictures that involve actions.

However, does reading about actions, or observing graspable objects, always imply motor simulation? This question was addressed in research by Eelen, Dewitte and Warlop (2013), who explored context dependency of the so-called motor fluency effect, or the tendency for people to prefer objects with which they can easily interact (e.g., Beilock & Holt, 2007). Presumably, individuals use the ease of simulation to guide reasoning and preferences (Elder & Krishna, 2012; Ping, Dhillon, & Beilock, 2009; Shen & Sengupta, 2012). Eelen et al. (2013) proposed that simulation is only needed when people take into account situational constraints (Jeannerod, 1995) and when habitual actions do not occur automatically (Norman & Shallice, 1983). If this is true, then motor fluency effects should only be observed when individuals are likely to monitor situational constraints. Eelen et al.'s findings point in this direction. Their studies compared rigid right-handers, people who always use their right hand for manipulating objects, with flexible right-handers, people who sometimes use the left hand when the environment affords it (e.g., when an object is in a left spatial location). Presumably, flexible right-handers monitor the spatial constraints more because they can respond to both left and right contingencies, whereas rigid right-handers respond habitually to right-hand affordances and ignore others. On the basis of this reasoning, in one study Eelen et al. showed participants objects that had no handle, a handle oriented leftward, or a handle oriented rightward on a computer screen and later asked them to recall the orientation of the handles and indicate their object preference. Compared with rigid right-handers, flexible right-handers recalled product orientations better and also preferred products on which the handle was oriented in the direction of the hand used for grasping. This finding suggests that action simulation was more likely to occur for flexible right-handers. Furthermore, in a follow-up study, when flexible right-handers were put under cognitive load, such that action planning in working memory was inhibited, the preference effects disappeared. Overall, the studies of Eelen et al. indicate that action simulation and its subsequent impact on preference does not occur for everyone in every situation. It seems that motor simulation occurs if action planning is needed to perform the cognitive operation at hand, which is consistent with the suggestion made earlier that simulation is most useful, and therefore most likely to occur, when semantic associations are only weak or ambiguous. Further evidence of the conditionality of embodiment can be found in research about emotion processing, which we discuss next.

EMBODIMENT IN EMOTIONAL PROCESSING

Most of the research on embodied emotional cognition can be roughly divided into two main areas. The largest area has established that the somatosensory–motor elements of emotional experience, such as the physical sensations of emotional expressions (e.g., the bodily feel of making a smile), contribute to higher order emotional processing. The other area has established that when people use emotional metaphors, such as those relating physical distance to emotional engagement or those relating temperature to emotional engagement, they make use of their capacities for sensing heat and appreciating physical distance. We review some core research in these two areas next. After that, we discuss potential relations of embodiment research to human mimicry and the application of embodiment research in autism and depression.

Emotional Processing and Embodied Simulation

William James was one of the predecessors of modern embodiment theories, and his canonical example of coming upon a bear in the woods is still a fine place to begin discussing modern embodied emotion theories. James (1994) said, roughly, this: You see such a bear, then your autonomic nervous system is automatically activated (i.e., your heart rate and blood pressure elevate and your legs want to carry you backward). On noticing your altered bodily state, you recognize that you are afraid. Modern emotion theories, of course, see the emotional causation as a much more complex event. Moreover, they do not take actual changes in bodily states to be necessary to experience an emotion, instead focusing on brain representation of somatosensory and motor processes (e.g., Damasio, 1999). However, the essential Jamesian point remains—the mentally represented bodily state is an integral part of emotional experience and an integral component of emotional processing. This core conceptual insight has been demonstrated in several lines of research.

Somatic Involvement in Valence Processing

A number of experimental results have now shown that abstract emotional processing interacts with bodily expressions. In an early demonstration, Chen and Bargh (1999) instructed participants to indicate the valence of presented words (e.g., *love*, *hate*) using a lever that could be either pushed or pulled. The experiment was motivated by the observation that people use the motor action of pushing, either as a practical action or as a communicative gesture, to avoid things they do not like but to pull objects that they like toward them or indicate their liking of objects to others via a pulling-type gesture. This, combined with the notion that specific motor actions are tied to abstract valence representation, led investigators to hypothesize that reactions to the task would be facilitated when the valence of the physical action was congruent with that of the concept being evaluated. This reasoning was borne out by the data, which revealed that response times for correct responses were faster when pushes indicated words with negative valence and pulls indicated positive valence. Similar findings have been reported by others as well (Cacioppo, Priester, & Berntson, 1993; Förster & Strack, 1997, 1998; Neumann & Strack, 2000). After the initial findings, several interesting debates developed. One lively and still continuing debate surrounds the relative automaticity of the approach–avoidance effects (Krieglmeyer, Deutsch, De Houwer, & De Raedt, 2010; Rotteveel & Phaf, 2004). The other debate concerns the possible symbolic nature of the valence–action link. Markman and Brendl (2005) argued that the effects are not tied to the physical direction of movement (forward–backward), the involvement of specific muscle groups (flexors–extensors), or even the direction of movement in relation to the body (toward me–away from me). Rather, they proposed that the effect depends on the location of the stimulus with respect to participants' symbolic representation of the self, which would, of course, suggest that any embodiment effects are mediated by higher order representation. In support of their idea, Markman and Brendl found that approach–avoidance effects occurred with respect to the location of the participant's name on the screen rather than with respect to the physical body. Specifically, participants responded faster when moving positive words toward their own name (localized on the computer screen) and negative words away from it than when moving positive words away from their name and negative words toward it. This was true regardless of whether moving closer to or away from the name involved the action of pushing or pulling. However, a recent study challenged Markman and Brendl's data and interpretation. Van Dantzig, Zeelenberg, and Pecher (2009) showed that very similar effects occur when the participant's name (presumably representing the disembodied self) is replaced by a positive word, a negative word, or even no word at all. So, for now it looks as though the unconstrained account of the approach–avoidance effect might be correct after all.

In this context, it is worth briefly mentioning three intriguing recent findings regarding the impact of embodied cues on approach–avoidance. First, adopting approach-type postures (e.g., leaning forward) results in increases in neural activation characteristic of approach situations (Harmon-Jones, Gable, & Price, 2011). Second, executing avoidance-type movements (pushing a shopping cart, as opposed to holding it) is associated with fewer reward-oriented consumer choices at the cashier's desk (Van den Bergh, Schmitt, & Warlop, 2011). Third, taking a step backward (which implies avoiding as well as distancing) is associated with increases in controlled (less impulsive) information processing (Koch, Holland, Hengstler, & van Knippenberg, 2009). Although these findings certainly require replication and extension, they raise the interesting possibility that influences of embodied approach–avoidance cues go beyond highly restricted, immediate, and arbitrary linguistic stimuli.

Affect as a Type of Modality

Experiments using the switching paradigm (similar to that of Pecher et al. [2004], discussed earlier) have suggested that affect can be considered as a modality unto itself (Vermeulen, Niedenthal, & Luminet, 2007). In those experiments, participants had to verify auditory (*KEYS–jingling*) and visual (*TREASURE–bright*) features of nouns that were either neutral or had a strong affective value (either positive or negative). Each target pair was preceded by a priming pair (e.g., *TRIUMPH–exhilarating* followed by *COUPLE–happy*). The structure of these pairs was experimentally manipulated so that participants had to consecutively verify properties of either the same or different modalities (visual, taste, auditory, affective) with either similar or different valences (positive or negative). For example, a same-modality–same-valence pair might be (*TANK–khaki*/*WOUND–open*), whereas a different-modality–same-valence pair might be (*TANK–khaki*/*SOB–moaning*) and a different-valence–different-modality pair could be (*TANK–khaki*/*VICTORY–sung*). The findings showed that verifying features of concepts from different modalities produced costs of longer reaction times and higher error rates than concepts from the same modality. Critically, these costs included switching between affective and other modalities. Costs of crossing processing modality while keeping valence constant were also found. These results are hard to account for with an amodal, purely propositional model of concept representation, which views affect as just another node in the semantic network.

As indicated earlier, much research attention in the embodiment literature is currently focused on understanding when people simulate and what particular features they simulate. Recent experiments have explored the contextual nature of the embodied simulation process in understanding abstract mental states (Oosterwijk et al., 2012). These states can be affective (e.g., anger, happiness) or cognitive (e.g., thinking, remembering). The idea here is that understanding of abstract concepts referring to mental states can vary depending on what perceptual perspective is activated. Specifically, many mental states have a clear internal component—people feel a certain way when they are in these states (e.g., anger feels hot, memory retrieval feels effortful). These internal experiences may be simulated when people understand conceptual references to mental states. However, mental states can also be described from an external perspective. In those cases, simulation of visible outside features may be more relevant for understanding (e.g., anger makes the face red, memory retrieval involves head scratching). In a switching-costs paradigm, participants saw semantically unrelated sentences describing emotional and nonemotional mental states while manipulating their internal or external focus. Results showed that switching costs also occur when participants shift between emotional and cognitive sentences with an internal and external focus. These results suggest that different forms of simulation underlie understanding mental states from different points of view.

This conclusion is important because it shows that even very abstract concepts are perceptually grounded and subject to perspective effects, in which different properties of abstract mental states are revealed.

Embodiment of Facial Emotions

Many demonstrations of how bodily experiences can augment emotion processing come from research on the recognition of emotional facial expressions. Until recently, expression recognition was thought to be mostly a matter of detecting features (e.g., curves at the corners of the mouth, lines in the corners of the eyes) that are probabilistically associated with an expression (e.g., smile). In other words, the recognition of a smile was assumed to be very much like the recognition of any other stimulus (e.g., recognizing that an analog clock is showing 2:45). In contrast, embodied accounts of expression detection emphasize the role that somatosensory representations of one's own face play in the process (Barsalou, 1999; Damasio, 1999; Niedenthal et al., 2005). From the embodied perspective, one can think of the act of smiling, for example, as a partial simulation of the state of happiness, which can verify, via facial feedback, a match between one's own state and the mood of the person that one is imitating.

Much evidence has been found for the correlational links between expression recognition and activation of spontaneous facial motor movements (e.g., Dimberg, 1982) and greater activity in the somatosensory areas of the brain (e.g., Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003). Critically, research on the recognition of facial expressions has also provided some evidence for the causal, constitutive role of embodied simulation in emotion recognition. For example, preventing participants from engaging expression-relevant facial muscles impairs their ability to detect briefly presented or relatively ambiguous facial expressions that involve that muscle (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Oberman, Winkielman, & Ramachandran, 2007). Lesion studies that examined the effects of (a) damage to the sensorimotor areas and (b) temporary inactivation of the face area with repetitive transcranial magnetic stimulation further support that motor representations causally contribute to recognition of facial emotion (Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000; Pitcher, Garrido, Walsh, & Duchaine, 2008). Of course, these findings do not mean that embodiment is always involved in processing of facial expressions or that it is always causally necessary. For example, patients with facial paralysis (Moebius syndrome) can learn to recognize expression using nonembodied routes (Rives Bogart & Matsumoto, 2010). Moreover, autistic participants can also develop alternative routes to recognition (see the section Autism later in this chapter). The critical point here is that typical perceivers will activate the somatosensory networks in the course of everyday processing, especially when the recognition cannot be achieved via a simple, highly automated pattern-recognition strategy.

Emotional Language

Recent evidence has highlighted interesting links between the facial feedback process and the processing of emotional language. In one provocative study, Havas, Glenberg, Gutowski, Lucarelli, and Davidson (2010) first used subcutaneous injections of Botox to temporarily paralyze the facial muscle used in frowning and then had participants read emotional sentences. Data suggested that participants were slower in understanding emotional sentences that involved the use of the paralyzed muscle. Another study explored the links between embodied processing of emotion words and embodied processing of faces (Halberstadt, Winkielman, Niedenthal, & Dalle, 2009). The idea was that people's actual facial reactions to other individuals' faces interact with conceptual information about those faces communicated via language and that these motor–conceptual interactions might serve to support and hold as well as distort memories of other people's facial expressions. In Halberstadt et al.'s (2009) studies, participants were first asked to look at faces of several different individuals with ambiguous facial expressions and think about why each of these individuals might possibly feel happy or angry (the concept labels were randomly paired with the face). Later, participants were asked to recall what exact expression was presented for each individual. The data showed that participants' memory of the expression was biased in the direction of the earlier language concept (e.g., remembering a face as happier when it was earlier associated with a happy label). Critically, this memory distortion was related to the degree to which the conceptual label assigned to the expression (happy or angry) elicited a corresponding facial electromyography response during the initial perception of the face. Presumably, this concept-driven motor representation got tied to the actual perceptual representation of the face and later served as a retrieval cue. As Zajonc (1980) pointed out, the body is often where perception and conceptions meet.

Conditional-, Context-, and Resource-Dependent Simulation of Emotion Concepts

As described earlier, many studies have reported involvement of somatic processes, such as facial action, when people process abstract emotional stimuli. Serious interpretive objections remain, however. Relevant findings could be interpreted not as evidence of simulation (an attempt to build a physically grounded representation of the abstract concept) but as evidence of emotional reaction. That is, simulation could trigger previously associated emotions, regardless of whether the participant requires them or not. In response to this objection, we note that recent findings have indicated that people are more likely to recruit relevant physical resources when they have to understand the meaning of an abstract emotion concept. Moreover, studies have also shown that the range and specific shape of such somatic processes are sensitive to context. Finally, results of other recent studies have demonstrated that embodied responses play a causal role in emotional understanding. All such findings argue against the idea that bodily responses solely reflect only emotional stimulation (not simulation). Instead, they are consistent with models of situated and embodied cognition in which such processes play a valuable informative role with respect to the current internal and external environment. Let us be more specific.

Niedenthal, Winkielman, Mondillon, and Vermeulen (2009) conducted research that explicitly addressed these concerns. In their studies, participants viewed emotion words (e.g., concrete nouns, such as *sun* or *slug,* or abstract words, such as *foul* and *joyful*). Some participants were simply asked whether words were capitalized or not (a perceptual task), and others were asked whether the word was associated with an emotion (a conceptual task). During this task, the activation of participants' facial muscles was measured via electromyography. Consistent with idea of context-dependent, strategic use of modal processing, the results showed that facial muscles were subtly activated in emotion-specific patterns when participants were evaluating the meaning of the words but not when they made judgments of letter case. These results clearly argue against an emotional reaction account according to which measured emotions are actually just reflexive reactions to reading the word.

Another experiment also addressed the question of whether embodiments are simply emotional reactions or causally contribute to emotion understanding. Half of participants received instructions to hold a pen in their mouth—a manipulation that interferes with production of expressions of happiness and disgust (Oberman et al., 2007). Thus, this manipulation should also interfere with processing of emotion words, if motor expressions are indeed important. Consistent with this hypothesis, participants were less accurate in classifying words related to the specific emotions of happiness and disgust when the facial movements specific to these emotions were blocked by the pen.

Finally, Niedenthal et al. (2009) conducted an experiment explicitly designed to manipulate the strategic need for emotion simulation. Participants generated features of emotional concepts (e.g., frustration) and were informed that the features were being produced for an audience that was, depending on condition, interested in either hot emotional features of the concepts or cold emotional features of the concepts. EMG measurements were taken during the performance of the feature-generation task. Interestingly, participants were able to produce normatively appropriate emotion features in both the hot and the cold conditions. However, the physiological results showed greater activation of the expected sets of facial muscles when participants were asked for features of emotion words in the hot condition than when they were asked for these features in the cold condition. This greater activation shows that embodied simulations are recruited in concept understanding, but only if they are relevant to solving the task (cf. L. L. Wu & Barsalou, 2009). Presumably, in this but not the other condition, participants try to mentally generate features of, say, frustration, by first re-creating a relevant experience and then reading off its features from associated embodiments—which is important because it argues against the idea that embodiments are passive by-products of conceptual processing (sensorimotor reflexes that are just "there for the ride"). Also, the study qualified the strong embodied claims somewhat because participants in the cold condition were able to successfully generate emotion features, albeit in a more dictionary-like way.

Returning to the simulation versus emotional reaction objection, it is worth highlighting how Niedenthal et al.'s (2009) findings go beyond earlier observations that emotional imagery triggers bodily signs of the corresponding emotion. For instance, Grossberg and Wilson (1968) found that when participants imagined situations that typically evoke emotions (e.g., fear), they showed changes in heart rate and skin conductance. Schwartz and his colleagues (Brown & Schwartz, 1980; Schwartz, Fair, Salt, Mandel, & Klerman, 1976) found that when individuals engaged in positive imagery, activity over zygomaticus major (the smiling muscle) was greater, but when individuals engaged in negative imagery, activity over corrugator supercilii, the frowning muscle, was greater. Such results support the conclusion that emotional imagery is accompanied by corresponding physiological changes, and they are indeed consistent with an embodied simulation account. However, the studies by Niedenthal et al. (2009) went beyond these findings by highlighting that (a) embodiment is conditional depending on task needs and (b) embodiment is causally involved in understanding emotional content. Also, together with other studies on the embodied representation of emotional language (e.g., Havas et al., 2010), the Niedenthal et al. findings highlighted the role of somatosensory resources in understanding higher order conceptual content.

Specificity and Appropriateness of Embodied Resources

As more research is conducted using embodied cognition as a guiding theory, it is also becoming increasingly clear that understanding embodied effects on emotion requires more differentiated theories about how somatosensory and motor systems are involved in a given task. This general point has been made repeatedly in different guises. For example, Riskind (1984) observed that performance on a subsequent task was best when posture was appropriate to the outcome of a previous puzzle-solving task. The explanation at the time was an appropriateness hypothesis: Postural response that is appropriate to circumstances results in an overall positive shift in affect; postural response that is inappropriate produces negative affect. However, what determines appropriateness? Recently, Harmon-Jones and Price (Harmon-Jones et al., 2011; Harmon-Jones & Peterson, 2009; Price, Peterson, & Harmon-Jones, 2012) have applied the framework based on approach and avoidance orientations to interpret and study emotional embodiment effects. In this framework, emotions associated with approach include anger and joy, in contrast to avoidant emotions such as fear, anxiety, and disgust. Relevant neurophysiological measures include asymmetries in frontal cortical electroencephalographic activation, with left-sided activation indicating approach and right-sided activation indicating avoidance; the late positive potential component of the event-related potential; and the magnitude of the eye-blink component of the startle reflex. Behaviorally, approach- and avoidance-related physical motions involve moving part or all of the body toward versus away from a stimulus, leaning forward versus backward, or using flexor versus extensor muscles.

For example, in an investigation of approach- and avoidance-related physical responses to face images, Van Peer et al. (2007) found evidence that physical response can be made more rapidly when affectively congruent with stimuli. Using arm flexion (an approach movement) to press a button was more rapid when viewing happy than angry faces, whereas the opposite was true when the button press required arm extension (see Rotteveel & Phaf, 2004). Moreover, the motor effect of viewing angry faces was heightened by administration of cortisol versus placebo to highly anxious participants, providing additional evidence that the effect is linked to emotional context. Thus, physical movements are not context independent—they are enhanced or interfered with by specific affective contexts.

Conversely, approach- and avoidance-related body postures have been shown to have distinct influences on affect depending on context. Harmon-Jones and Peterson (2009) investigated cortical electroencephalographic response to anger elicitation in both upright and reclining postures. In the upright posture, hearing a negative evaluation by a peer increased participants' left cortical electroencephalographic activity, associated with approach activation. However, no such response was observed in the reclining position. Thus, the upright position appears to have special significance in the context of interpersonal ego threat. Most recently, Price, Dieckman, and Harmon-Jones (2012) found that forward-leaning body posture leads to diminished startle magnitude and larger late positive potential responses to those pictures, but only when the pictures were appetitive, creating a context of potential reward. In contrast, this effect was completely absent when neutral pictures with no appetitive value were displayed.

Finally, preliminary findings by Wielgosz, Repshas, Greischar, and Davidson (2012) have suggested that anxiety and affective response to threat are also embodied and context situated. Postural manipulation was combined with an established paradigm for detecting psychophysiological consequences of uncertain threat (Moberg & Curtin, 2009), with magnitude of the startle eye-blink reflex as a primary measure. Participants were instructed to assume either a protective body position, by raising the shoulders toward the neck, or an open, confident body position, by drawing the shoulders back. Meanwhile, during half of the experimental blocks, a threat context was created by displaying a visual warning and delivering mild, temporally unpredictable electric shocks. During the other half of blocks, no shocks were administered, and a corresponding indicator was displayed.

According to the appropriateness hypothesis suggested by Riskind (1984) and others, protective posture is associated with anxiety, and thus in a nonthreatening context its incongruence should result in greater startle magnitude. However, under threat, protective posture should be an appropriate response and thus reduce negative affect. Meanwhile, open posture should produce precisely the opposite effects. This study's results showed just such a pattern, with a significant interaction between posture and threat conditions and simple effects that suggests the expected crossover interaction.

Stimuli and responses in these findings have important social dimensions. Slumped and upright postures communicate information about goal achievement to others. Stimuli used by Van Peer et al. (2007) consisted of happy and angry faces. Anger elicitation in Harmon-Jones and Peterson (2009) consisted of insulting verbal feedback. Appetitive images used by Price et al. (2012) consisted of erotic stimuli. Finally, open and closed body postures have been strongly associated with power-related interactions within social dominance hierarchies (Carney, Cuddy, & Yap, 2010; Huang, Galinsky, Gruenfeld, & Guillory, 2011). In all these cases, body position and movement had effects that were both significant and context dependent.

The social environment is complex and dynamic, and it demands context-appropriate affective responses. The lines of research summarized here, as well as others, provide increasing evidence that situated and embodied aspects of emotion processing contribute to generating such responses. Domains in which this has been demonstrated include goal achievement, approach and avoidance, and interpersonal threat or safety. Contextual effects in other areas of social cognition will thus constitute an important and promising area for ongoing investigation.

Embodied Emotion Metaphors

In addition to relying on emotion-specific modalities to abstractly reason about emotion, one can also use nonemotional perceptual input to think about emotions, enabled by the use of metaphor. Consider a restaurant where you feel most at home. It may have a warm waiter who talks to you in a familiar way. In contrast, the places you least like to go (e.g., government offices) may be described as being cold. Your high school friend can be described as being close to you, or perhaps you have since gone different directions and have actually gotten quite distant from each other.

Several lines of research have suggested that thinking about emotion is metaphorically tied to physical distance and temperature. One set of studies showed that manipulations of physical distance can increase feelings of emotional distance (Williams & Bargh, 2008a). In these studies, participants were primed with a manipulation that asked them to plot two points on two-dimensional space, with some participants plotting points that were very close together and others plotting points quite far apart. Subsequently, participants who plotted two points very far apart perceived themselves as having weaker emotional attachment to their hometowns and family members. In two other studies, participants plotting more distant points enjoyed a story about embarrassment more and were less affected by a story relating a harrowing and violent experience than participants plotting close points (presumably because they felt more distance from the situations presented). Although some researchers have recently raised doubts about the robustness of particular effects (Pashler, Coburn, & Harris, 2012), there seems to be a wide agreement that psychological distance is a reliable determinant of emotional responses (Trope & Lieberman, 2010).

Another set of studies used a similar logic and primed participants with physical sensations bearing on the embodied metaphor for warmth (Williams & Bargh, 2008b). These studies showed that participants found an interaction partner to be a warmer person when, in an unrelated task, they were holding a warm cup of coffee rather than a cold one. In a related line of research, Zhong and Leonardelli (2008) asked some participants to recall an experience of social rejection and others to recall an experience of inclusion. Afterward, both groups were asked to estimate the temperature in the room; those who recalled a feeling of exclusion guessed significantly lower than did those who recalled a feeling of inclusion (21.44 °C vs. 24 °C). A second experiment in the same study involved a "cyberball" manipulation in which participants played an online game. This game was supposedly multiplayer, but in fact all participants were playing with a computer program that either included or excluded them in a game of catch. After this game, participants were given a marketing survey that had them rate the desirability of various kinds of food and drink, some warm and some cold (cold soft drink vs. hot coffee, hot soup vs. an apple). Participants who were excluded (tossed a virtual ball just two times out of 30) rated hot items as more desirable than those who were included (tossed the ball an equal number of times as all other players). Finally, a recent provocative result suggests that psychological coldness (social rejection) may even literally reduce skin temperature (IJzerman et al., 2012).

Another line of research has suggested that bottom-up embodied cues influence which conceptual metaphor guides emotion understanding. Note that multiple metaphors are usually available for understanding an emotional state. One classic example of this is love, which can be understood as a journey, a flower, or a game (Lakoff & Johnson, 1980). But why is a specific metaphor preferred? And how does it guide understanding of emotion material? These questions were addressed in an exploratory study by Tseng, Hu, Han, and Bergen (2007). They had noticed that similar emotion words, such as *happiness* and *joy,* are differently associated with metaphorical frames. Thus, the expression *searching for happiness* is more common than *searching for joy,* whereas the expression *full of joy* occurs more often than *full of happiness.* Thus, subtly activating different metaphors through embodied cues should influence which emotional term—*joy* or *happiness*—is applied to ambiguous emotional material. To test this, the experimenters approached participants as they were either searching for something (e.g., a book in a library) or drinking something from a container. Participants were then shown a photo of a person with a very positive facial expression and asked whether it was better described as happiness or joy. As expected, participants who were drinking (and presumably activated the container metaphor) were more likely to describe the picture as showing joy, whereas people who were searching were more likely to describe the expression as happiness.

This work fits well with studies on embodied moral metaphors. These studies have shown that the physical act of washing seems to remove the negative feeling associated with a moral transgression. In an experiment by Zhong and Liljenquist (2006), participants were asked to write about a past moral transgression and then either cleaned their hands with wipes or did not. They then filled out an emotional state questionnaire and were later approached (without forewarning) about participating in another study for a desperate graduate student. In previous studies, the reliving of moral transgressions had been shown to increase the propensity to engage in good deeds, and this propensity held in Zhong and Liljenquist's study but only for participants who had not cleaned their hands. Those who had already cleaned their hands were less likely to help the graduate student and also reported more desirable scores for moral emotions such as disgust, regret, guilt, shame, embarrassment, and anger but not for amoral emotions such as confidence, calm, excitement, and distress. Another experiment in the same study showed that engaging in unethical behavior increased desire for cleaning products.

In the same vein, Lee and Schwarz (2010) showed that the need for cleansing induced by immoral action was specific to the body part used for the dirty deed—participants asked to type a lie showed a greater preference for hand wipes, whereas participants who spoke a lie preferred mouthwash. It is important to note that the connection between physical cleanliness and morality is not completely straightforward, with some studies reporting that cleanliness reduces the severity of moral judgments (Schnall, Benton, & Harvey, 2008) and other studies reporting that cleanliness enhances their harshness (Zhong, Strejcek, & Sivanathan, 2010). Clearly, how specifically a bodily feeling translates into an abstract moral decision must depend on a variety of interpretational factors (e.g., "Who is clean here? Me, or the target of judgment?").

MIMICRY AS EMBODIED SOCIAL COGNITION

As we have discussed, people have a tendency to copy others' facial expressions. Of course, mimicry extends beyond faces and includes the tendency for people to adopt each other's movements, gestures, and vocal expressions. One advantage of the embodiment framework is that it provides a conceptual link across this varied mimicry literature. Gestural and postural mimicry have frequently been linked to affiliation and rapport between the mimicked party (model) and the person doing the imitating. Individuals who like each other tend to mimic each another, and being mimicked by another person tends to increase one's feelings of affiliation toward that person (Chartrand & Bargh, 1999). These tendencies have led to mimicry being labeled as a form of social glue because it seems to foster cohesion between social groups (Lakin, Jefferis, Cheng, & Chartrand, 2003). Embodiment theories explain why this is the case: Mimicry contributes to creation of the same somatically grounded emotional state, thus facilitating understanding. More important, just as with other forms of embodied information, the effects of dyadic mimicry are moderated by contextual information. One of most basic forms of information relevant to social cognition is group membership. Indeed, recent studies have shown that gestural mimicry by an in-group member makes one feel socially and physically warmer, but mimicry by an out-group member makes one feel colder (Leander, Chartrand, & Bargh, 2012). These data are consistent with previous work on facial mimicry that found that negative attitudes toward the model are associated with countermimicry (Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008), and subliminally priming the concept of competition reduces (and even reverses) facial mimicry, which makes sense in contexts in which the opponent's loss or win is the perceiver's win or loss (Weyers, Mühlberger, Kund, Hess, & Pauli, 2009).

Interestingly, mimicry's function is not limited to directly interacting parties. As stated earlier, third-party observers can also use the level of mimicry in an interaction to judge the amount of affiliation between two people. Moreover, observers can also make social judgments about people on the basis of whom they mimic. In some situations, third-party observers will infer from the presence of mimicry that the members of the party are socially related and positively affiliated (Bernieri, 1988). Note, though, that such inferences can be more complex. For example, Kavanagh, Suhler, Churchland, and

Winkielman (2011) found that if a target person mimics a model who is rude to the person, third-party observers of this interaction will judge the mimic as incompetent, even when observers fail to notice the presence of mimicry. In fact, in that situation the mimic was rated as less competent then the nonmimic, which initially seems paradoxical. However, it makes sense if one thinks of mimicry as an embodied cue to social competence. If a person chooses to mimic a rude model, the person is nonselective or injudicious in his or her embodied responses or, in other words, socially incompetent. In short, inferences supported by embodied cues can be quite complex and context dependent. This does not challenge the value of embodiment theories but suggests that subtle influences of observed bodily states on one's perception of relationships and inferences about traits are conditional on social context and are only beginning to be understood. Just to highlight this point, Kavanagh et al. (2013) have shown that when processing mimicry information, observers take into account not only whether people mimic or not but also the reputation of the model and whether the mimicker is aware of the model's reputation.

In general, mimicry research has raised conceptual challenges to research on both embodied and disembodied representations in social cognition. From the perspective of embodiment theories, although there are many interesting findings, there is not yet an accepted explanation for the function of behavioral mimicry. Is it mostly an epiphenomenon—a simple by-product of frequent perception–action links (Heyes, 2011)? After all, one usually see one's legs cross when one makes that movement and see smiles when one makes them. Is it a processing strategy in service of better understanding (Goldman & Sripada, 2005), or is it a tool for social regulation (Hess & Fischer, 2013)? Besides a few studies in the facial mimicry domain, there have really been very few attempts to answer these questions in the domain of gestural and vocal mimicry.

In terms of amodal frameworks, one characteristic of mimicry that is difficult to account for is its unconscious production and detection by the mimic and the model as well as by third parties (observers of mimicry). This unconscious production and detection has been established by detailed funnel interviews at the end of studies on the effects of mimicry in dyads and those that measure the effect of third parties' evaluations of mimics (e.g., Chartrand & Bargh, 1999; Kavanagh et al., 2011). When participants are asked in these interviews to say what influenced their attitude toward a mimic, a small minority mention body language at all, and of those that do a small number (often none) explicitly notice mimicry. Even a final question asking explicitly whether the participant noticed mimicry routinely fails to produce an affirmative response. If processing does indeed take place in amodal networks and the activation of nodes in these networks tends to raise them to the level of awareness, it is difficult to see how a behavioral phenomenon that leaves little trace on explicit awareness can be influencing one's high-level judgments of another's character. It seems more likely that mimicry allows one person to shift into a modality-based state similar to that of another, without the mediation of language-like code. From an embodied perspective, it is not surprising that an explicit languagelike representation of mimicry never enters consciousness of either the mimic or the model. Information contained in postures about somatic states is not prelinguistic (waiting to be transduced before it can affect processing); rather, this information is complementary to language and fundamentally alinguistic, perhaps so much so that transduction would be either counterproductive or impossible. It is perhaps worth noting here that much nonverbal communication functions like this, making exploration of this process of even more general interest.

The theory and evidence summarized here seems to suggest that mimicking another's gestures and postures may help one to better understand the other's emotional state, allowing one to think in the same way as the other. Pushing one's arms forward in the same way as one sees another do, or even merely simulating the act, will induce a similar modal state in the mimic. The previously cited research on the importance of modal thinking also points out how important the attainment of a similar modal state can be. The modal states that seem most likely to be captured by mimicry are emotional and somatic. The impulse to put oneself in the same somatic and emotional states as another would seem to reveal a desire to understand the other. Because such changes in expressions and posture are inherently visible, the act of putting oneself in a similar somatic and emotional state can, by its nature, be simultaneously a communication of this intention. This communication may explain why mimicry seems to play a causal role in affecting the feelings of the model toward the mimic. As always, these speculations await empirical testing.

EMBODIMENT AS A TOOL FOR IMPROVED SOCIAL BEHAVIOR

So far, we have reviewed the foundation of an embodied perspective on social cognition, including modal simulation of both nonemotional and emotional concepts. We have also surveyed a variety of ways in which this perspective enhances basic theoretical understanding of everyday social cognition, including links between facial mimicry and emotional understanding of interpersonal interactions, as well as a remarkable range of nonemotional somatic influences on both mood and morality. The embodied perspective can also be usefully applied to understanding apparent deficits or atypical forms of social processing with fruitful results. We consider here the cases of autism and depression, two significant examples of clinical conditions in which social functioning plays a central role.

Autism

Underlying embodiment may shed light on certain developmental disorders with a large social component, such as autism. For example, in contrast to typical participants, individuals with autism do not spontaneously reproduce (mimic) facial expressions when they just watch them, that is, without any prompts to recognize the expressions or to react to them (McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006). Even when individuals with autism are explicitly asked to focus on recognizing facial expressions, their mimicry is delayed (Oberman, Winkielman, & Ramachandran, 2009). Because numerous other studies have shown that spontaneous mimicry aids emotion recognition, there is reason to suppose that such deficits may hinder understanding of nonverbal cues by autists (see Winkielman, McIntosh, & Oberman, 2009, for a fuller review of theory and evidence in this area). People affected by autism have also been shown to have impairments in nonemotional empathy and understanding of other minds (mentalizing). As discussed, these skills are partially supported by the ability to construct an embodied simulation of the other.

If it is indeed true that embodiment is part of the autistic deficit, it should, interestingly, be possible to improve these individuals' real-life emotional communication skills by training embodiment. Success in such a program would also provide a powerful example of how theories of social cognition can inform and facilitate actual interpersonal behavior. One domain in which this can be easily achieved is facial mimicry, where quick motor reactions to faces can be developed by frequent pairing of a stimulus and motor response (smile to smile, frown to frown). In fact, we recently tested this idea in our lab by using a training paradigm in which typical participants produce facial expressions in response to schematic facial stimuli (Deriso et al., 2012). The initial results are encouraging and suggest that facial imitation training may indeed improve facial recognition. Future studies in our and related labs will extend these interventions to participants with autism. One reason to expect that this training paradigm may be beneficial are earlier findings suggesting that participants with autism spectrum disorder show improvement in face perception after playing face-related video games (Tanaka et al., 2010). We are also planning an intervention program with a humanoid robot that makes realistic facial expressions (T. Wu, Butko, Ruvulo, Bartlett, & Movellan, 2009). An interested reader can find several videos of this robot via a simple Internet search with the words *Einstein robot UCSD*. We hypothesize that these perception–action pairings will enhance the ability of participants with autism spectrum disorder to quickly mirror facial expressions, which in turn will facilitate not only their recognition of faces but will also make others judge them as more socially appropriate.

Depression

Embodied perspectives may also be valuable in improving social behavior in the large number of individuals who suffer from mood disorders and their related symptoms. Basic research on embodied emotional and social processing has pointed to several areas ripe for further exploration in a specifically clinical context. In particular, major depressive disorder, the most widespread and costly of psychiatric diagnoses, is strongly linked to social cognitive processing in both its causes and symptoms (Barnett & Gotlib, 1988; Dodge, 1993; Hirschfeld et al., 2000; Kaplan, Roberts, Camacho, & Coyne, 1987; Keltner & Kring, 1998). Difficulty with social interactions (Segrin, 2000), reduced social contact (Youngren & Lewinsohn, 1980), low self-esteem, loss of close relationships (Monroe, Rohde, Seeley, & Lewinsohn, 1999), loneliness (Heinrich & Gullone, 2006), social rejection (Slavich, O'Donovan, Epel, & Kemeny, 2010), lack of social support, and low social status (Kaplan et al., 1987) have all been identified as risk factors or contributors to its onset. Meanwhile, symptoms and outcomes of depression include anhedonia (inability to experience pleasure), more stressful interpersonal events, lowered mood, altered social attributions (Abramson et al., 1999), and increased loneliness (Lasgaard, Goossens, & Elklit, 2011). These and other effects can have a dramatic impact on quality and quantity of social interaction, functioning, and support. Some models suggest these effects can in fact form a cycle in which deterioration of social support and dysregulation of mood become mutually reinforcing (e.g. Hammen, 2006).

Because mood is communicated and reinforced using embodied cues, giving attention to the embodied dimensions of social interaction may be a valuable tool in helping depressed people replace this vicious cycle with a virtuous one, wherein interactions can instead generate positive affect and improved relationships, which in turn alleviate the symptoms of mood disorder. To illustrate this, we discuss several relevant facets of embodied social cognition and explore their potential for therapeutic use. The persistent sad mood and loss of positive emotions found in depression have been shown to manifest in body posture, motor activity, and facial expressions. For example, depressed patients show alterations in gait that include reduced walking speed, arm swing, and vertical head movements (Michalak et al., 2009). Feelings of disappointment lead to decreases in postural height (Oosterwijk, Topper, Rotteveel, & Fischer, 2010). As mentioned, loneliness is associated with physical coldness, leading to recent suggestions that it may relate to greater use of warming resources in the environment (Bargh & Shalev, 2012). Rumination on negative content is likely to lead to frowning in a way similar to reading negative emotional content (Foroni & Semin, 2009). Automatic mirroring or mimicry of these emotions (Neumann & Strack, 2000) is likely to be a factor in the transmission of depressed mood during social interactions (Hatfield, Rapson, & Cacioppo, 1994) and the subsequent negative reaction to depressed affect (Segrin & Abramson, 1994).

However, with attention, the body is often easier to voluntarily control than mental states or emotions. By learning to be aware of nonverbal, embodied components of social interaction, depressed individuals may be able to preserve the quality of their social interactions by interfering with the process of emotional contagion. Conscious efforts to maintain open, expansive body posture and to smile and move in an energetic manner, although they may be incongruent with inner emotional state, will produce positive emotions when mirrored by others, making a valuable difference in the quality of social interactions. Although the focus here is on social interaction, posture and facial expression also appear to have a bottom-up influence on one's own mood, which may be a considerable benefit as well. Facial and postural expressions prime the specific emotions with which they are associated, including sadness and happiness (Flack, 2006; Flack, Laird, & Cavallaro, 1999). Moreover, muscle groups that are used frequently tend to strengthen, and those that are not tend to atrophy. Therefore, over time, repeated somatic expressions of sadness could become involuntary, contributing to a tendency toward lowered moods and greater persistence of such moods as well as greater difficulty in consciously projecting positive affect as described earlier.

One caveat worth noting is that consciously replacing expressions of sad mood with positive expressions may have the greatest value when done judiciously. Evidence has indicated that when framed as suppression, such conscious control of outer expression can take an emotional, physiological, and cognitive toll (Richards & Gross, 1999). Thus, although excessive facial and bodily expression of negative emotion may lead to somatic priming of negative moods, it may also be necessary to balance this with the need to express genuine emotions without hiding them, underscoring the need for careful study of embodied social cognition in this area. Because prolonged expression of negative affect is in many contexts considered socially undesirable, depressed people have a social incentive to suppress the expression of their affective state (Butler & Gross, 2004). Finding or creating contexts in which some facial and bodily expression of negative emotions is acceptable—for example, in therapy, support groups, or through explicit changes to family and social norms—may also be valuable for relieving the stress associated with chronic suppression of emotional embodiment. Embodied influences may also contribute to the maintenance of depressed mood through influence on memory retrieval. Dijkstra, Kaschak, and Zwaan (2007) showed that memories can be retrieved more easily when posture is congruent with the mood relevant to the memory. Thus, maintaining postures, and by extension gait and facial expressions, characteristic of positive mood may result in preferential recall of positive memories, ameliorating depressive recall biases (Gotlib, 1983).

Emotion perception is another dimension of social interaction in which embodied effects may provide a way to counter the effects of depressed mood. Depression alters attention toward emotional stimuli and their appraisal. However, by modeling positive emotions in the face and body, it may be possible to counteract these biases. For example, inhibiting facial expressions of negative emotion interferes with the processing of corresponding emotional language (Havas et al., 2010; Niedenthal et al., 2005) and may thus counterbalance attentional focus on negative stimuli. Because facial expressions are also important to evaluative judgments (Foroni & Semin, 2009), consciously expressing positive emotion may also facilitate efforts to perform adaptive, mood-improving cognitive reappraisal (Gross & John, 2003; Joormann & Gotlib, 2010) of ambiguous situations and challenges. Finally, as mentioned earlier, one basic determinant of emotional responding is psychological distance. So, it would be interesting to explore whether embodied manipulations of distance make people feel emotionally less engaged with (distant from) their psychological problems. The manipulation of distance could range from simple techniques such as taking a few steps backward (Koch et al., 2009) to arranging environments in ways that promote abstraction (e.g., minimalistic settings).

Another key symptom of depression is anhedonia, or diminished motivation to seek normally rewarding behaviors. Depressed individuals differ from controls in the activation of approach and avoidance systems (Vergara & Roberts, 2011). At the same time, depressed patients show a tendency to spend extended periods lying down, for example, staying in bed for long periods. According to Harmon-Jones and Peterson's (2009) electroencephalographic studies, such supine posture decreases the left cortical activation typically associated with approach motivation when presented with a social challenge. A recent review by Price, Peterson, and Harmon-Jones (2012) catalogued much further evidence that approach and avoidance systems can be differentially activated by motor changes such as leaning forward versus reclining, using the arm flexors versus tensors, and unilateral activity on the right versus left side. Thus, even the simple act of getting out of bed and sitting upright may improve approach motivation, which is a necessary precondition for seeking out social contact and maintaining social interactions. The fact that embodied theories of emotion and social cognition can incorporate such simple yet possibly significant acts into therapeutic context indicates their value in extending existing psychotherapeutic models that were derived from and rely primarily on narrower, information-processing models of cognition.

Finally, embodied factors are also important in the perception of power, which is diminished in depression in the form of low self-esteem as well as feelings of helplessness. As discussed elsewhere in this chapter, postures associated with social dominance produce power-related social behaviors and even endocrine changes (Carney et al., 2010), as well as complementary behavior by social partners (Tiedens & Fragale, 2003). Posture may in fact be a key factor in producing behaviors associated with high or low social power (Huang et al., 2011). Depressed mood is described as "feeling low," whereas high vertical positions are associated with greater power (Schubert, 2005). Thus, by habitually holding low-dominance postures, depressed patients may in practice lower their own status in social interactions, which in turn reinforces low mood. Feelings of inefficacy are also central to the learned helplessness model of depression (Abramson, Seligman, & Teasdale, 1978), and they turn out to be strongly primed by posture. Riskind (1984) showed that body posture affects persistence after success or failure on an initial task: After initial success, slumped body posture led to less persistence on a subsequent task than upright posture, but after initial failure, the results were reversed. Habitually slumped posture could therefore contribute to feelings of helplessness, because successes would be followed by decreased persistence. Yet again, consciously maintaining open, powerful postures or seeking out high places—for example, living on a top-floor rather than a basement apartment—could counteract these tendencies.

To summarize, embodiment theory can contribute to improving social function in mood disorders in at least four major areas. First, consciously embodying positive emotions in gait, expression, and posture can potentially counteract the contagion of depressed mood that undermines social support; at the same time, social acceptance of the expression of genuine emotions, including negative ones, may be important in preventing psychological and physiological stress resulting from suppression. A certain amount of such conscious embodiment of positive emotion may also have the beneficial effect of priming recall of positive memories. Second, embodied influences can influence emotion perceptions during social interaction and may thus help depressed individuals counteract the effect of negative cognitive schemas (Beck, 1987) on their interpretations of others' behavior. Third, embodied effects can influence appraisal in social contexts—use of approach-oriented body postures and motions can also help counteract tendencies toward avoidance and facilitate the initiation and maintenance of social contact. Fourth, embodied processing can be used to counteract feelings of low social power and self-efficacy, for example, by maintaining upright rather than slumped body posture or by spending time in physically elevated places rather than in low ones.

Direct applications of embodiment theory to disorders involving social functioning are still in their nascent stages, but the accumulation of basic research indicates that this area will be a promising one in which a broader, embodied, and situated perspective on social cognition can contribute to addressing important clinical issues. Future research in this area will ideally be addressed through collaborative efforts involving both social cognition researchers and experts in developmental, clinical, and other applied areas.

CONCLUSION

In this chapter, we discussed theory and evidence for embodiment of cognition and emotion. We illustrated that embodied resources are often routinely activated in information processing, including higher order conceptual tasks. They can play a causal and necessary role in understanding and can be flexibly deployed by perceivers to facilitate mental processing. While enthusiastically embracing the embodiment perspective, we nevertheless agree with most psychologists that a satisfactory account of most psychological phenomena must also consider the role of abstract, conceptual thought. As such, future work is likely to be devoted to better understanding the interplay between modal, analogical representations that actively utilize the perceptual, somatosensory, and motor resources and the conceptual resources that utilize languagelike symbols.

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