How do emotions move us? Embodied and disembodied influences of emotions on social thinking and interpersonal behavior.

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"*There are probably very few perceptions and cognitions in everyday life that do not have a significant affective component, that aren't hot, or in the very least tepid. And perhaps all perceptions contain some affect. We do not just see "a house": we see "a handsome house," "an ugly house," or "a pretentious house." We do not just read an article on attitude change, on cognitive dissonance, or on herbicides. We read an "exciting" article on attitude change, an "important" article on cognitive dissonance, or a "trivial" article on herbicides. And the same goes for a sunset, a lightning flash, a flower, a dimple, a hangnail, a cockroach, the taste of quinine, Saumur, the color of earth in Umbria, the sound of traffic on 42nd Street, and equally for the sound of a 1000-Hz tone and the sight of the letter Q." Bob Zajonc, 1980, p. 153-154*

We live in an emotional world. From the very beginning of life, human babies either giggle and smile or they fuss and cry – there is rarely a 'neutral' moment in their life. And those parents, whose babies are emotionally flat, have good reasons to worry. Parents, who have been waiting for their child maturing into a stoic adolescence, quickly give up hope. In the adult world, lovers flirt, colleagues scorn, students brownnose, and bosses frown. Even domains that could certainly use some dispassionate reasoning, such as politics are imbued with emotion. Thus, voters are either enthusiastic and hopeful about political candidates or afraid and disgusted by them. In fact, there is probably not a single 'awake' US citizen who does not have some form of emotional response to the names of Bill Clinton, Barack Obama, Sarah Palin, and George Bush. People are rarely cool even to abstract, impersonal entities -- they are trusting or afraid of the government, engaged in or indifferent to the society, passionate about social justice or hateful towards entitlements, buoyant or scared about the future, "mad as hell" or confident about the economy. Fueling all this is, of course, a constant river of emotional appeals from interest groups, advertisements, charities, school boards, friends and colleagues. The role importance of emotional stimuli and states in judgment, decisions and social behavior is now well documented (for an overview, see Eich, Kihlstrom, Bower, Forgas, & Niedenthal, 2000; Forgas, 2005). But how does this work? Just what happens when we see a smile, read a political slogan, watch an exciting advertisement, or catch an inviting gesture? The goal of this chapter is to present recent research on the mechanisms underlying processing of emotional stimuli from our and related labs. We will present this research with the overall goal of highlighting new insights into emotion processing offered by theories of embodied cognition.

Here is a rough plan of the chapter. We begin by placing embodiment theories in the context of debates about the nature of mental representation. We then review evidence for the embodiment account in several domains of emotion processing. We cover research on emotional perception, comprehension, learning, influence, concepts, language, imitation, and influence on social behavior. We close with some challenges for the embodied theories of emotion.

Propositional Models of Emotion Perception and Representation

A saying goes "A smile is a curve that sets everything straight." But how do we perceive and understand emotional stimuli, such as faces. Until recently, faces were considered to be processed just like any other complex, highly-learned stimuli. We have sophisticated algorithms for feature extractions (the mouth curve, the eyes, etc) which feed that information into algorithms for feature combination and meaning derivation. In short, recognizing a smile is, more or less, like recognizing that a wall clock tells 10:10. The fact that we actually have faces plays little or no role in this account.

How do we represent abstract emotional concepts? Until recently, higher-order emotion knowledge was thought to be primarily represented in semantic networks composed of interconnected nodes corresponding to language-like propositions (Bower, 1981). When one of these basic units of knowledge is activated, it then activates connected units according to the strength of semantic association (Collins & Quillian, 1969). Once the degree of activation of a particular unit passes a critical threshold, then knowledge represented by that unit rises to the level of conscious awareness, and from there it may in turn affect behavior. These semantic models account for emotional states as a central unit of information (e.g. “anger”), which are linked to antecedents (“injustice’, ‘lack of freedom’), beliefs (“anger must be managed”, “disrespect can cause anger”), correlations (“angry people speak in raised voices”), and physiological patterns associated with anger (frowning, fist clenching, boiling rage) . When anger is experienced, the anger unit is activated, and it then diffuses activation to these associated concepts making them more accessible to consciousness and, relatedly, more relevant for interpreting and generating behavior. Conversely, activation can spread from nodes associated with anger to the anger node, generating the emotion itself (see Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Niedenthal, 2007, 2008).

Embodied Representation of Emotion Knowledge

Feature extraction models and semantic network models assume that direct sensory and bodily experience plays little role in the formation or transformation of knowledge In contrast to these accounts, embodied cognitive accounts assign sensory modalities and motor processes a significant role (Barsalou, 1999; Damasio, 1999; Niedenthal, Barsalou, Winkielman, Krauth- Gruber, & Ric, 2005). Thus, as we discuss below, recognizing a smile often involves a partial simulation of the smile in ourselves, whereas understanding the concept of ‘anger’ involves a partial simulation of what it feels like to experience anger.

More specifically, the central idea here is that processing an emotional stimulus or a conceptual episode involves the recreation of the neural states that occurred when one originally experienced that emotion (Niedenthal, 2007; see also Cacioppo & Petty, 1981, and Lang, 1979, for earlier related arguments). This recreation – called embodied simulation -- does not have to be a conscious, full-blown emotional episode. It only reinstantiates enough of the original experience or experiences to be useful in conceptual processing. Importantly, such simulations do not result from associative connections of emotion concept to somatic states. They are also not reducible to a feature list or description. Instead, they are constructive reinstantiations done when it is necessary to represent this conceptual content in information processing.

Evidence for Embodied Models from Non-emotional Domain

Evidence for embodied models of representation has been obtained with multiple tasks and methodologies. Studies using reaction times in a classic task of property verification (e.g., “Do cars have SAILS?”) found that variation in the perceptual features of judged objects was predictive of the speed of property verification (Solomon and Barsalou, 2004). For example, properties that were larger were verified more rapidly, presumably because they were easier to “find” on a representation. Studies using feature generation tasks found that the perceptual characteristics of a particular object (i.e. the visual or auditory characteristics) influenced the features that participants produced (Wu and Barsalou, 2009). For example, when participants had to list the features of the concept, HALF WATERMELON, they were more likely to spontaneously produce the features ‘seeds’ and ‘red’ compared to 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 extended also to quite novel concepts such as GLASS CAR (as opposed to CAR) showing that the patterns of performance could not be due to stored associations between amodal propositions. The above-mentioned studies are representative of findings supporting embodied cognition, but there are many others (Gallese & Metzinger, 2003; Glenberg & Kaschak, 2002; Pecher, Zellenberg, & Barsalou, 2003; Stanfield & Zwann, 2001; for a review of the embodiment of linguistic meaning, see also Gibbs, 2003).

A lot of neuroimaging research has been recently devoted to testing the role of perceptual and motor mechanisms in concept representation. In one of the pioneering studies, Kan, Barsalou, Solomon, Minor, and Thompson-Schill (2003) showed that variation in the activation levels of brain areas involved in perception (i.e. visual cortex & auditory cortex) during feature recognition tasks was explained by whether the feature in question was associated with a particular perceptual area. Patterns of brain activation during these tasks calling for open ended feature generation yield similar results (Simmons, Hamann, Harenski, Hu, & Barsalou, 2008).

It must be noted that not all require embodied processing of a particular concept, and purely semantic processing may be more appropriate in some cases. For example, embodied processing is superfluous if semantic associations between an object and its property are sufficiently strong that the property may spring to mind almost immediately on processing of the object name (e.g. Beaver, Builds Dam) (Solomon & Barsalou, 2004). 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 task does not require generation of internal properties, then they are not simulated (Wu & Barsalou, 2004).

A final, and highly convincing line of research that further confirms the importance of modal processing as well as identifying specific modalities, is that on switching costs between modalities. Perception researchers have shown that changing the focus of attention from one sense modality to another (switching from audition to vision, for example) slows reactions times on the second tasks, implying a cost to switching (e.g., Spence, Nicholls, & Driver, 2001). Pecher and colleagues generalized this finding to modal processing (2003; Pecher, Zeelenberg, & Barsalou, 2004) with 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 (versus the same) modality (e.g., “BOMB-loud” followed by “LEMON-tart”). This evidence is consistent with the idea that some modality specific part of the brain is activated when we process a given concept. The reasoning is that, if a just-used modality is appropriate for the processing of the next concept, then it should already “on-line” or activated when the next concept is processed, so one might expect the next concept to be processed more quickly.

In similar experiments, Vermeulen and colleagues (Vermeulen, Niedenthal, & Luminet, 2007) extended this same methodology to test the idea that affective processing appears to take place within a specialized modality. They had subjects verify auditory and visual features of stimuli that either had a strong affective value (either positive or negative) or both. Their findings showed that verifying features of positive and negative concepts from different modalities produced costs of longer reaction times and higher error rates. Furthermore, switching costs were observed also when switching from the affective system to sensory modalities, and vice versa. There results are hard to account for within an amodal, purely propositional model of concept representation. It is well known that similarly valenced words prime one another. This is explained in semantic models by bidirectional connections of both words to an affective node, but though this model does not predict that use of visual processing or auditory processing should impede or facilitate the flow of activation through these nodes.

Somatic Involvement in Emotional Word Processing

There’s been long line of evidence in social psychology that emotional words are tied to physical manifestations. In an early study in this area Chen and Bargh (1999) had participants indicate the valence of presented words (e.g., love, hate) either by pulling a lever toward them or by pushing it away. Whether a push or a pull indicated positive or negative valence was changed from trial to trial, however. The gesture of pushing something away from oneself is generally associated with items or people that ones dislikes (avoidance behavior) while the act of pulling something near to oneself is more consistent with those things that we like (approach behavior). If somatic experiences (in this case pushing and pulling) are intimately involved with cognition (in this case the judgment of valence and decision about the direction in which to push the lever) then identification should be easier when it is achieved by a physical act that has a valence similar to that of the word being identified (congruence). Consistent with this reasoning, participants identified the valence of positive words more quickly when positive valence was indicated by pulling the lever toward them and correctly identified negatively valenced words when this was achieved by pushing the lever away, indicating that categorization of the words' valence is facilitated by a congruent bodily state. Similar findings have been reported by Neumann and Strack (2000); Forster and Strack (1997, 1998); Cacioppo, Priester, and Berntson (1993). In summary, the findings suggest that the meaning of emotional words is at least tied to the motor states involved in the approach versus avoidance responses to the words' referents (Niedenthal, 2007).

The above studies seemed to point to these motor states influence on cognitive processing as associative, and almost accidental. In contrast, recent theorizing on embodied cognition points to ways in which body-mind connections could actually be an effective part of processing in the social domain. In more recent studies Niedenthal and colleagues (Niedenthal, Winkielman, Mondillon, and Vermuelen 2009) have shown that more abstract emotional concepts are processed through embodied means, but only when this necessary in order to grasp their meaning. In their first experiment, participants viewed both emotional and unemotional words (a distinction established by pre-testing), with some participants simply being asked whether words were capitalized and some asked whether or not they were associated with a particular emotion. All the while, the activation of participants' facial muscles was measured via EMG. Consistent with ideas of modal processing, the results showed that facial muscles were activated in a pattern consistent with the emotional associations of a word when participants were evaluating emotional meaning, but not for judgments of letter case.

A second experiment, which was just like the first except that abstract adjectives rather than concrete nouns were used, yielded similar results. This shows that emotional adjectives a more abstract type of word, are also processed through embodied means. A third condition repeated the methodology of first two except that half of participants were instructed to hold a pen in their mouth – a manipulation that blocks expressions of happiness and disgust (Oberman et al., 2007), and thus should also block emotion processing if expressions are important. Consistent with this hypothesis, participants were less accurate classifying words related to the specific emotions of happiness and disgust when the face movements specific to these emotions were blocked by the pen.

In a final experiment subjects were asked to generate features related to 32 concepts that were evenly divided among the following categories: neutral, anger-related, disgust related, happiness related. Participants were told that the features were being produced for audience, which was, depending on condition, described either as being interested in “hot” emotional features of the concepts, or in “cold” features of the concepts. EMG measurements were taken during the performance of these tasks. The results showed there was greater activation of relevant facial muscles when participants were asked for features of emotion words in the “hot” condition, than in the “cold” condition. This shows that simulations are selectively recruited in concept understanding, only if they are relevant for solving the task (cf. Wu & Barsalou, 2004).

But isn’t it all old news? Don’t we know, for example, that internal emotional stimulation (e.g., imagery) triggers bodily signs of the corresponding emotion? For instance, when individuals engage in positive imagery activity over zygomaticus major increases, whereas negative imagery activates corrugator supercilii (Brown & Schwarz, 1980; Schwartz, Fair, Salt, Mandel, & Klerman, 1976). It is worth highlighting how the just reviewed findings by Niedenthal and colleagues (2009) differ from those earlier observations. First, note that the imagery studies say little about how individuals represent abstract conceptual content, such as words. Second, they do not show the conditionality of embodiment depending on task needs. Third, these studies do not provide evidence that conceptual understanding is facilitated by these simulations (or stimulations). On the other hand, one can think of embodied cognition ideas as growing out of research on the role of imagery in comprehension (Kosslyn, 1976).

Embodiment of Facial Emotions

In some way, processing of faces provides the most obvious example of embodied processing. After all, we are all aware of processes of imitation, contagion, and mirroring, all of which has long been debated as a potential contribution to recognition. But the solid empirical evidence is more recent. Wicker et al. (2003) found the inhalation of disgusting odors and watching videos of other people making disgust produced similar patterns of neural activation. Tbe insula and also, to a lesser extent, the anterior cingulate cortex were activated in both cases. This evidence along with many other experiments suggests that the understanding of others actions and experiences and performing an action or having an experience oneself may be processed by highly overlapping neural circuits (for related evidence with other facial expressions, see Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Dimberg, 1990; Halberstadt, Winkielman, Niedenthal, & Dalle, 2009; McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006).

Research on the recognition of facial expressions also provides some evidence for the causal role of embodied simulation in emotion processing. For example, preventing participants from engaging expression-relevant facial muscles can impair their ability to detect facial expressions that involve that muscle (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Oberman, Winkielman, & Ramachandran, 2007). In summary, both correlational and causal evidence suggests that embodied simulation is involved in perception of facial expression of emotion (see Niedenthal, 2007, for a fuller discussion).

Mimicry as Embodied Social Cognition

People's tendency to copy facial expressions that they have just seen others make is called "facial mimicry", and provides the strongest link to embodiment and a wider mimicry literature. Human behavioral mimicry is the tendency of people to adopt each other's movements, gestures, and expressions. Gestural and postural mimicry has been linked in the past to affiliation and rapport between the mimicked party (model) and the person doing the imitating. People who like each other tend to mimic one another, and being mimicked by another person tends to increase one's feelings of affiliation towards that person (Chartrand & Bargh, 1999). Onlookers also can use the level of mimicry in an interaction to judge the amount of affiliation between two people (Bernieri, 1988) and make social judgments about mimics based on who their model is (Kavanagh, Suhler, Churchland, & Winkielman 2010). These tendencies have led to mimicry being labeled "social glue" because it seems to cohesion between social groups (Lakin, Jefferis, Cheng, & Chartrand, 2003). This is a descriptive rather than explanatory account, however. Though there has been a lot of interesting findings with regard to behavioral mimicry there is not yet any widely accepted explanation for the purpose of this pattern of behavior, or if it is an epiphenomenon, an explanation of the purposeful behavioral that tendency underlies it. Based on the evidence, it seems that there is a good chance that embodied cognition will end up being part of this answer.

The characteristic of mimicry that is most perhaps most difficult to account for in an amodal framework is that it seems to be unconscious both in its motivation and expression, as established by detailed funnel interviews at the end of studies eliciting spontaneous mimicry and on those that measure the effect of mimicry on models evaluations of them (e.g. Chartrand & Bargh, 1999). If processing does indeed take place in amodal networks and the activation of nodes in these networks tends to raise these to the level of awareness, it is difficult to see how a behavioral phenomenon that leaves no trace on awareness can be affecting our judgments of another's character. It seems more likely that mimicry allows one person to shift into a modal state similar to that of another, without the mediation of language-like code. From an embodied perspective it is not surprising that an explicit language like representation of mimicry never enters consciousness of either the mimic or the model. Information contained in postures about somatic states is not “pre-linguistic” (waiting to be transduced before it can effect processing), but rather this information is *complementary* to language but fundamentally “a-linguistic”, perhaps so much so that transduction would be either counterproductive or impossible.

The summarized theory and evidence above seems to suggest that mimicking another’s gestures and postures may help to better understand their emotional states, to think in the same way that they do. Pushing one’s arms forward in the same way that one sees another do this, 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. Recent studies that show how one’s facial expression can influence even abstract word processing demonstrate that imitation of expressions may be important for social understanding.

Conclusion

The current chapter focused on advances in understanding of emotion processing. We argued that the idea that emotions are mentally represented as a set of amodal language-like symbols – lists or networks of features, propositions – needs to be replaced, or at least supplemented by an embodied simulation account, which assumes that emotion concepts rely on modal, analogical representations that actively utilize the brains somatosensory and motor resources. This new understanding is essential for us to appreciating how emotion concepts function in the social world. Underlying embodiment may even shed light on certain developmental disorders with a large social component, such as autism. For example McIntosh et al (2006) have shown that autistic individuals do not automatically reproduce (mimic) facial expressions that they see in others, as do typically functioning participants. As numerous other studies have shown that this reproduction aids recognition, there is reason to suppose that a deficit in reproduction may hinder understanding of non-verbal cues in autists (See Winkielman, McIntosh, & Oberman, 2009 for a fuller review of theory and evidence in this area). People affected by autism have been shown to impairments in empathy and understanding of "other minds" (mentalizing). As discussed there skills are partially supported by the ability to construct an embodied simulation of the other.

In sum, we believe that the account presented here offers a more promising way of understanding the functioning of emotional knowledge, and generates several exciting new hypotheses. Social cognition may never become fully embodied, but it will become better if it appreciates that the basis of social knowledge is richer, more comprehensive, more fleshed out than long assumed by our models.

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