

Is social cognition embodied?

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Theories of embodied cognition abound in the literature, but it is often unclear how to understand them. We offer several interpretations of embodiment, the most interesting being the thesis that mental representations in bodily formats (B-formats) have an important role in cognition. Potential B-formats include motoric, somatosensory, affective and interoceptive formats. The literature on mirroring and related phenomena provides support for a limited-scope version of embodied social cognition under the B-format interpretation. It is questionable, however, whether such a thesis can be extended. We show the limits of embodiment in social cognition.

Introduction

A spectre is haunting the laboratories of cognitive science, the spectre of embodied cognition (EC). For decades, the reigning paradigm of cognitive science has been classicism. On this approach, higher cognitive functions are analogized to the operations of a computer, manipulating abstract symbols on the basis of specific computations. As embodiment theorists tell the story, classical cognitivism (CC) claims that mental operations are largely detached from the workings of the body, the body being merely an output device for commands generated by abstract symbols in the mind (or the 'central system' of the mind). Embodiment theorists want to elevate the importance of the body in explaining cognitive activities. What is meant by 'body' here? It ought to mean: the whole physical body minus the brain. Letting the brain qualify as part of the body would trivialize the claim that the body is crucial to mental life, simply because the brain is the seat of most, if not all, mental events.

Proponents of EC are found in virtually all sectors of cognitive science. They include artificial intelligence [1], psychology [2–5], cognitive neuroscience [6,7], linguistics [8] and philosophy [9–12]. However, embodiment seems to mean widely different things to different EC theorists, and their views range from the radical to the not so radical. In view of this diversity, it is impossible to canvass all varieties of EC (for review see Ref. [13]).

We begin by laying out four general constraints on a conceptually satisfying and empirically fruitful definition of EC. (i) A definition should assign central importance to the body (understood literally), not simply to the situation or environment in which the body is embedded. Many theorists more or less equate EC with situated cognition; we focus entirely on the former. (ii) The definition should concentrate on the cognizer's own body, not the bodies of

others. Perception of another person's body should not automatically count as EC. (iii) Any substantial EC thesis should be a genuine rival to CC. (iv) It should also make a clear enough claim that its truth or falsity can be evaluated by empirical evidence. After assessing candidate definitions of EC in terms of the foregoing desiderata, we shall choose our favorite candidate (not necessarily excluding others) and apply it to social cognition. We shall ask how strongly the current empirical evidence supports EC as a thesis about social cognition.

Interpretations of embodiment

We shall formulate four definitions or conceptions of embodiment (Figure 1). Because many pre-existing formulations of embodiment are rather opaque, we hope that our proposals will bring increased clarity to this matter. For any conception of embodiment, of course, it could be claimed that 'all' of cognition is embodied, or that '90%' of cognition is embodied, etc. Nobody is in a position to address this quantificational issue with any precision and we shall leave this question open here, merely assuming that EC theses want embodiment to have, at least, an 'important' role.

Body anatomy interpretation: parts of the body have an important causal role in cognition in virtue of their distinctive anatomy

This definition is motivated by such obvious facts as this. If we had the bat's system of echolocation instead of human eyes, we would perceive the world differently than we do. Thus, the physical body (distinct from the brain) influences the nature of our perceptions. This characterization of EC does not conflict with CC. No advocate of CC would disagree with this trivial claim. Therefore, constraint (iii) is violated and this interpretation is unacceptable.

Bodily activity interpretation: one's actions and other body-related traits (e.g. posture) have an important causal role in cognition

An example of embodiment under this interpretation is facial feedback. According to the facial feedback hypothesis, one's own facial musculature activity affects one's mood or emotion [14–16]. The bodily activity interpretation, however, faces a dilemma. On the one hand, cases in which actions or bodily conditions affect cognition are often quite trivial, and recognized by all programs for cognitive science. All theorists, including CC theorists, would cheerfully grant that opening or closing the eyes affects one's perceptions. This is a case in which bodily activity influences cognition (i.e. perception), but it hardly separates EC from CC. On the other hand, there are more ambitious EC

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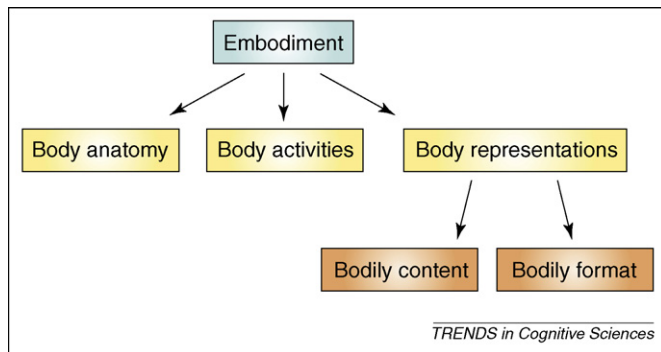


Figure 1. Taxonomy of embodiment theses. Classification of alternative interpretations of the notion of embodiment.

theories that are variants of the second interpretation. Some claim that the body and its activities ‘ground’ a variety of our concepts [4,8,17]. Others claim, not merely that bodily activity causes perception, but that perception consists of or is constituted by, sensori-motor contingencies [11]. However, this strong form of an embodied theory of perception (or perceptual experience) is difficult to defend. True, a well-known study found differences of perceptual development in a kitten that was able to explore its environment as contrasted with a kitten required to be passive [18]. And wearing inverting goggles, which changes sensorimotor contingencies, results in reorganization of perception. However, these results only show that sensorimotor contingencies have ‘effects’ on perceptual experience, not that they ‘constitute’ perceptual experience [19].

Not all versions of EC focus on the body *per se*. Some focus on mental representations of the body – although other EC theorists object to mental representations altogether (e.g. Refs [1,2]). How would mental representations of or about the body enter the picture?

Bodily content interpretation: mental representations with bodily contents have an important causal role in cognition

It is not entirely clear how this interpretation would work in detail. In fact, we prefer to let this third interpretation serve merely as a jumping-off point for a fourth interpretation, which we find more congenial. First, let us introduce the shorthand ‘B-reps’ for bodily representations, a class of mental representations. Next, let us distinguish representations classified as bodily in virtue of their bodily contents (B-contents), with representations classified as bodily in virtue of being encoded in bodily formats (B-formats). B-formats will now become our primary concern.

The idea of a code or format of mental representation is familiar in cognitive science, although there is no consensus about what formats there are or how to individuate them [20]. Some formats are modality-specific: a visual format, an auditory format and so forth. It is also common to postulate an amodal, or purely conceptual, format. What is the relationship between a particular mental format and the contents of that format’s tokens?

We suspect that formats are partly individuated by the contents that their tokens characteristically bear, but that is not the only individuating feature. Representations in

different formats can have partly overlapping contents. So, there must be a second factor that has something to do with the neural network that underpins the format. Thus, ventral and dorsal visual pathways are presumed to be different visual codes or formats not only because of presumably different contents but also because of their different neural pathways. However, this is not the place to try to say the last word on the question of format individuation.

Let us now revisit the suitability of our third interpretation, the B-content interpretation. Is this suitable to EC? On reflection, it is quite out of the spirit of many forms of EC. If someone represents her own body by means of an amodal, purely conceptual format, then even though the content of the representation is bodily, many proponents of EC might not want to classify it as an instance of EC. This suggests that bodily formats are crucial to embodiment. Thus, we turn to our fourth interpretation of EC:

Bodily format interpretation: mental representations in various bodily formats or codes have an important causal role in cognition

We regard this interpretation of EC as the most promising one for promoting an embodied approach to social cognition.

Note that, even collectively, our interpretations do not cover all aspects of all EC positions in the literature. For example, some EC position statements feature claims about the inability of standard inferential or computational mechanisms to accommodate the phenomena, appealing instead to the ‘body’ (or the ‘situation’) to do the explanatory work. None of our interpretations of EC explicitly says this. Second, many proponents of EC advance highly global theses about embodiment, whereas our interpretations do not make such claims. Our interpretations are useable in either local or global embodiment claims. For these reasons, both proponents and opponents of EC might criticize our interpretations on the grounds of being excessively tame or ‘sanitized’. There is some justice to this charge, but we regard sanitized variants as scientifically and philosophically fruitful. It makes sense to recognize that selected cognitive tasks might be executed via embodied processes, without ascending to more global claims.

Evidence for embodied social cognition

It is worth noting that the mere fact that most social activities involve the perception of bodily behaviors does not qualify them as embodied. Which types of social-cognitive activities, then, are prime candidates for being embodied? According to proponents of embodied social cognition (ESC) [10,21–23], there are six favorite candidates, including behavior imitation, joint action, emotional contagion, empathy, mindreading and language understanding (for language understanding, see Box 1). However, not all of these meet our criteria for embodiment. Imitation and joint action involve an influence by other people’s bodily movements on one’s own [24,25], so they are not ways that one’s own movements and postures affect one’s cognitions. The situation is different in emotional contagion via facial mimicry [14,16,26]. When a receiver’s

Box 1. Embodied language

In discussing the embodiment of language, Gallese [21] distinguishes between phono-articulatory aspects of language and semantic aspects. Concerning the embodiment of the former, a TMS study [64] showed that listening to phonemes induces an increase in amplitude of motor-evoked potentials (MEPs) recorded from the tongue muscles involved in their execution. Embodied simulation at the semantic level concerns the semantic content of a word, verb or proposition. At the behavioral level, study [5] asked participants to judge if a read sentence about actions or transfer of information from one person to another was sensible by making a response that required moving towards or away from their bodies. Readers responded faster to sentences describing actions whose direction was congruent with the required response movement, both for sentences describing literal spatial movement and sentences describing abstract movement (information transfer). At the neural level, the authors of Ref. [65] found a congruence in the left premotor cortex (a prime mirror area) between effector-specific activations of visually presented actions and actions described by literal phrases. Thus, it seems that conceptual processing of linguistic phrases describing actions re-activates the same cortical sectors activated by observing actions made with the corresponding effectors [7].

However, we would like to emphasize the narrow scope of what these findings show. They reveal that premotor areas are activated when hearing sentences or verbs about motoric actions. However, sentences or verbs about motoric actions are a very limited domain of sentences. If that were all that embodied semantics could establish, it would be a very limited victory.

facial expression mimics that of the sender, facial feedback is a sub-process of a larger social process of mental contagion [27] (Figure 2). This is a clear instance of an embodied social process under the bodily activity interpretation.

Yet physical mimicry cannot account for much of social cognition. If social cognition is importantly or pervasively embodied, it must be because of B-reps and their distinctive formats. Thus, the fourth interpretation of EC is the most fruitful. Applied to the social realm it says that representations using B-formats have an important role in social cognition.

Which B-reps have B-formats? It is plausible to posit many such formats. A motoric format is used in giving action instructions to one's hands, feet, mouth and other

effectors. A somatosensory format represents events occurring at the body's surface. Affective and interoceptive representations plausibly have distinctive B-formats, associated with the physiological conditions of the body, such as pain, temperature, itch, muscular and visceral sensations, vasomotor activity, hunger and thirst [28]. If these formats are exploited to represent actions or states of other individuals, these cognitions would be engaged in social cognition via B-formats. For example, in empathy, one might observe another's disgust expression, which in turn elicits a disgust feeling in oneself. If the disgust feeling involves a mental representation in a B-format ('the viscera are in such-and-such a state'), and if one labels or assigns this visceral-state representation to the other person (thinking of how she feels from 'the inside'), this is a representation of the other in a B-format. The same would happen when one imagines another's disgust.

More widely, representations with B-formats can be exploited for social purposes either during perception or during imagination of another individual in a specific state. The former corresponds to what is called 'mirroring', and has received the most empirical support. We shall thus focus on it, keeping in mind that B-reps can also be activated during imagination [29,30].

The discovery of mirror neurons opened a wide window on the possibility that some social cognition starts at a primitive level of motor planning [31]. The prelude to the discovery was finding a neural vocabulary in monkey premotor cortex in which types of actions (e.g. grasping, holding and tearing) are coded by populations of neurons. Some neurons indicate the goal of an act, others the manner in which a motor act can be performed [32]. This is clearly a motoric code, one also used in some types of social cognition. Cells in area F5 not only send movement instructions to the hand or other effectors but also echo instructions for the same movements when a monkey merely observes another monkey execute that movement [33] or hears action-related sounds [34]. Networks with mirror matching properties were also found in humans [35–37]. Whether participants see other individuals acting or hear action-related sounds, they activate effector-specific motor representations involved in the execution of the same action [38]. Mirroring for other experiences – including touch [39,40], pain [41,42], disgust [43] and pleasure [44] – soon followed.

Representations in B-formats are, thus, activated not only during fundamental motor, somatosensory, affective and interoceptive functions but also for some social-cognitive functions. Although the social role of mirror systems is still controversial [45], we believe that they do have such a role, as suggested by further empirical findings that argue in favor of such a social role, in addition to mirroring studies *per se*. First, mirror activity is often correlated with empathy or mindreading questionnaires [37,41,46]. These correlations indicate that mirroring has a social dimension. More precisely, we suggest that it has a role in action and emotion recognition. It was found that lesions affecting B-reps interfere with action and emotion recognition. Patients with selective impairment in emotion experience have a matching selective impairment in recognizing emotional facial expressions in other people,

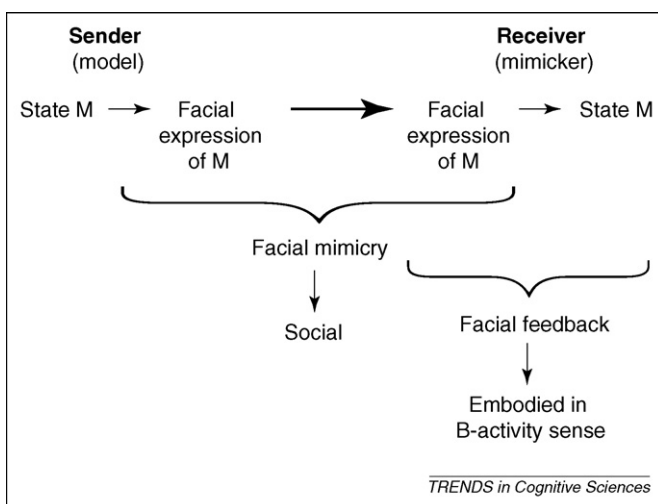


Figure 2. Emotional contagion through facial mimicry. A social process of mental contagion can be broken down into two stages. First, a sender's facial expression is mimicked by that of a receiver; second, the receiver's facial musculature influences his mood or emotion.

whereas they have a preserved declarative knowledge about the relevant emotion [47,48]. So, normal subjects, who have no such lesions, must be using their own emotion experience – involving a B-format – in recognizing the emotion of someone they observe. Similarly, apraxic patients with gestural-production impairments can have difficulties in recognizing action-related sounds, although this is not systematic [49]. Whether B-reps have a role in a wider range of social-cognitive functions (e.g. imitation [50], empathy [21], perspective taking [35], mindreading [46,48,51,52] and language production and comprehension [53,54]), as suggested by ESC proponents, is still being debated at the empirical level. Nonetheless, in the next section, we raise some conceptual worries concerning the extent of embodiment in social cognition in general.

Beyond embodiment

Our brief literature review makes an empirical case for the causal role of B-formats in a variety of social-cognitive activities. Because of the low-level nature of B-formats, such a pattern was never anticipated by CC. As noted, however, EC enthusiasts often make all-encompassing claims about the extent to which embodiment pervades cognition. Although our review identifies previously unsuspected relationships between B-formats and social cognition, it leaves it quite open how far B-reps extend into social cognition. To make a global assessment, prototypical forms of social cognition should be examined.

Three possibilities should be kept in mind. (i) Some social-cognitive tasks could be executed by two or more methods, one involving B-formats and others involving other formats. (ii) Even the involvement of B-formats might occur at only one stage of a compound process, in which non-bodily formats predominate. (iii) Many social-cognitive activities might involve no B-formats at all.

- (i) Empathy illustrates the first possibility: a social-cognitive activity that can be executed with or without B-reps. According to Refs [55] and [56], there are indeed two forms of empathy: ‘mirror’ empathy and ‘reconstructive’ empathy. Mirror empathy involves automatic re-activation of a given affective state in an observer, and this process can be dominated by the mirrored event occurring in a B-format. Reconstructive empathy is a more constructive and controlled process, which extracts information from memory in an endogenous production of the empathic event. The final empathy event might be couched in a B-format, but a great deal of non-bodily processing occurs in the run-up to its production.
- (ii) Even if some portion of a given simulation heuristic for mindreading (e.g. face-based emotion recognition) involves the mirroring of an emotion, other stages of the process, including the final attribution, could be devoid of any use of a B-format [48,52]. Note the differences here between different proponents of the simulation theory of mindreading. Gallese [21], who defends an explicitly embodied approach, maintains that some mindreading is constituted by mirroring, and involves no representation in propositional (non-bodily) format. This posits the deployment of B-formats to the exclusion of any other representational

Box 2. Embodiment and simulation

One theme that comes back frequently in EC and ESC is an apparent link between embodiment and reinstatement, reactivation or simulation [6,23]. Gallese [21] and Niedenthal [23] often speak of ‘embodied simulation’ in one phrase, strongly implying that all simulation is embodied. Why, one might wonder, are reinstatement or simulation crucial to embodiment? Mental simulation allows (in principle) the simulational mindreading of beliefs and (non-motoric) intentions, as Ref. [52] proposes with its notion of ‘high-level’ mindreading. It would be difficult, however, to make a case for embodied simulational mindreading of beliefs because the reinstatement of beliefs would not involve any B-format.

One might reply that only the re-enactment of low-level or modality-specific states is embodied. But what exactly makes sensory cognitions embodied? It cannot be their content because the content of sensory cognitions is presumably the external world, not the body. Noë [11] defends the embodiment of perception by arguing that it is tightly linked to action. In the absence of any such argument, however, why should it be presumed that perceptual cognition is embodied?

format. By contrast, we admit a role for mirroring as part of (low-level) mindreading, but regard the mirroring stage as only one stage of the mindreading process, a stage that causes but is not constitutive of the subsequent mental-state attribution *per se* [52]. This leaves more room for non-bodily representational resources to be deployed.

- (iii) Even defenders of the idea that mirroring has ‘some’ role in mindreading often restrict that role to ‘low-level’ mindreading such as emotion recognition or motor-intention prediction. For example, Goldman [52] proposes that face-based attribution of emotions (e.g. disgust) is implemented by a simulation procedure featuring the mirroring of disgust (which is a B-rep), but he equally acknowledges the existence of simulational high-level mindreading that is unlikely to involve any B-formats at all (for discussion, see Ref. [57]). Simulation, *per se*, does not entail the use of B-formats (Box 2). High-level mindreading would standardly involve propositional attitudes like belief and desire. A propositional attitude includes several components, including a type and a propositional content. For example, ‘Johnny THINKS that $25 + 27 = 52$ ’ has THINKING as its type and $25 + 27 = 52$ as its content. To be full and accurate, a mindreader must represent both components. Would either representation be a B-rep (occurring in a B-format)? That seems unlikely. Why would a representation of the mathematical content, $25 + 27 = 52$ be a B-rep? Equally, why would a representation of the state-type THINKING be a B-rep, expressed in a B-code? No evidence known to us supports these hypotheses. Furthermore, evidence that the representation of thinking is especially associated with the right temporo-parietal junction (RTPJ) indicates the contrary [58] (but see Ref. [59] for a contrary view).

Finally, many other processes involved in social cognition are separate and distinct from mindreading (Table 1). When interacting with someone, you must recognize who the person is, ascribe personality features to her, categor-

Table 1. Samples of social cognition

Person recognition	Face perception, body perception, gait perception, etc.
Personality perception	Trustworthiness, competence, friendliness, fairness, shyness, friendliness, adventurousness, etc.
Membership perception	Gender, race, age, political opinion, religion, etc.
Social beliefs	Prejudice, social scripts, stereotypes, etc.
Social mechanisms	Self/other distinction, gaze detection, perspective-taking, empathy, mirroring, intentionality detector, etc.
Mindreading	Emotion, bodily sensations, intentions, desires, beliefs, etc.
Social attitudes	Envy, pity, contempt, admiration, like/dislike, shame, trust, sympathy, etc.
Social interaction	Imitation, competition, communication, collaboration, punishment, revenge, help, deception, reward, exclusion, etc.

ize her relative to the group to which she belongs, and perhaps apply prejudicial beliefs about her group and prototypical social scripts to guide your behavior.

To what extent are these various aspects of social cognition embodied? Here, we highlight a few studies on personality trait attribution and prejudice-based judgments. It was found that the dimensions of warmth (e.g. friendliness, helpfulness, sincerity, trustworthiness and morality) and competence (e.g. intelligence, skill, creativity and efficacy) account almost entirely for how people characterize others [60]. Perceiving someone's warmth and competence, however, is not like perceiving someone's current emotion. At the computational level, personality judgments involve complex calculations requiring the collection of information over time and the drawing of inferences [61]. This computational complexity is hardly compatible with ESC. Even when personality judgment is on-line based on poor perceptual information like short point-light walker body movements, it was found that it activates neural bases distinct from those activated by emotion recognition [62]. Of particular interest here, the authors found greater activity for personality judgments in the medial prefrontal cortex previously associated with propositional-attitude mentalizing. This result is consistent with a recent meta-analysis of brain imaging studies, which found that the attribution of enduring dispositions of others and the knowledge of interpersonal norms and scripts engage the medial prefrontal cortex [63]. Thus, it has not been shown that social cognition is pervasively embodied.

To promote future development of the EC approach, we challenge embodiment theorists (and their critics) to formulate and defend their claims by answering the following questions. First, which interpretation of embodiment do they have in mind? Second, which sectors of cognition, or which cognitive tasks, do they say are embodied; and how fully does each task involve embodiment? Third, how does the empirical evidence support the specific embodiment claims under the selected interpretation(s)? Fourth, how do the proffered claims depart substantially from CC? In our opinion, the findings discussed earlier (in the section 'Evidence for embodied social cognition') do provide support for a limited-scope version of ESC under the B-format interpretation. It is doubtful, however, that such a thesis can be generalized. Researchers who fly their ideas under the banner of EC sometimes advance more far-reaching theses than the evidence warrants. These matters can be clarified only if proponents of EC accompany their writings with detailed answers to the four questions recommended earlier.

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