

# Embodied Action as a ‘Helping Hand’ in Social Interaction

Jessica Lindblom (jessica.lindblom@his.se)

School of Humanities and Informatics, University of Skövde,  
P.O. 408, 541 28 Skövde, SWEDEN

## Abstract

Although embodiment has become an important concept in many areas of cognitive science during the past two decades, most research has focused on individual agents and their interactions with the environment. This paper focuses on the social dimension of embodiment, and offers a conceptual framework that addresses embodied actions in the social realm. The framework identifies some fundamental functions of embodiment in social interaction, which are also illustrated by a case study in an everyday social setting. Generally speaking, embodied actions provide a helping hand in social interaction, both in a literal and practical sense.

**Keywords:** embodiment; social interaction; joint action; dynamically embodied actions

## Introduction

The ability to engage in social interaction is one of the building blocks of human culture, and is the foundation for the complexity of social life and social cognition. Despite these facts, the main focus in most theories of embodied cognition has until now been on the relation between the individual body and its cognitive processes, in interaction with the physical environment (cf., e.g., Chrisley & Ziemke, 2003; Clark, 1999; Núñez, 1999; Riegler, 2002; Wilson, 2002; Ziemke, 2003).

However, Johnson and Rohrer (in press), for instance, point out that “*embodied cognition is often social and carried out cooperatively by more than one individual*”. Therefore, there is a need to move beyond the current emphasis on the interactions between the individual and the physical environment, to interactions between agents and their social environment. Others have recognized this as well, and argued that theoretical knowledge of embodiment needs to be extended beyond current notions and/or levels of ‘individual’ embodiment (cf., e.g., Anderson, in press; Lindblom & Ziemke, 2003; 2005, in press; Sinha & Jensen, 2000).

Many theories of social and cultural cognition tend to overlook the role of the body in social interaction by treating embodied social interactions such as body posture, gaze and gesture as nothing but the visible outcomes of mental intentions (cf. Tomasello, 1999; Tomasello *et al.*, 2005; Frith & Wolpert, 2004). On the other hand, the distributed cognition approach proposed by Hutchins (1995), for instance, treats these social interactions and the external materials involved, as directly observable *cognitive* events in the situated interaction (Johnson, 2001). With this crucial change in perspective, much of cognition that earlier was hidden ‘inside’ the skull has now become apparent.

That is, cognitive functions are manifested in artifacts, and dynamic and social processes can be directly observed and studied. However, the main focus in DC is on the flow and transformation of information through different media at a more general level, rather than the particular role of the body in these processes. This means, despite the emphasis on interactions between agents and their material as well as social surroundings, the DC approach offers not much on the embodied nature of human cognition, as usually conceived, and currently it is peculiarly ‘disembodied’.

This paper aims to complement the general understanding on the embodied nature of social interaction and cognition, and therefore presents part of an emerging framework, which emphasizes the roles of dynamically and socially embodied actions in the social realm.

The rest of the paper is structured as follows. The next section presents research from different disciplines that stress the crucial role of embodiment in social interaction. Next, based on these issues, a theoretical framework is outlined, which portrays five fundamental functions of embodied actions in social interaction. Then an instrumental case study in an everyday social situation is presented, which illustrates parts of the developing framework. The paper ends with a summary and discussion.

## On the Embodied Nature of Social Interaction

Recent work in cognitive science and related disciplines indicates that the body plays several important roles in social interaction. In order to deepen our understanding of social embodiment, an integrated approach is necessary, which analyzes and identifies the fundamental functions of embodiment in social interaction and cognition. But so far there is no common theoretical framework considering such a crossdisciplinary approach.

In this paper, I will briefly address different perspectives, ranging from phenomenology, neuroscience, social psychology, and gesture to linguistics. These perspectives flow not only vertically through time but also horizontally across disciplines. There is, of course, much more research, that can and should be integrated conceptually, but due to space limitations, the aim here is limited to showing *how* crucial the body and its sensorimotor processes are in social interaction and cognition.

## Phenomenology

Already in the 1940s, the French philosopher Merleau-Ponty argued that *intcorporeality* constitutes the basis of intersubjectivity and social interaction (cf. Lindblom &

Ziemke, in press). Intercorporeality means that one's own lived body is the locus of intersubjective experience, which is based on the close intermodal links between visual perception, kinaesthetic-proprioception, and motor behavior (Gallagher, in press).

Moreover, Dautenhahn (1997) states that humans are very social creatures, with the ability to read 'social signs', emotions and states of another agent's mind. She argues that the phenomenological social understanding of others is based on an embodied simulation mechanism. That means, the body might be used as a mediator in the process of perceiving others. This mediation functions as a matching system that allows one to adopt other persons' point of view by simulating their mental states with a resonant state of your own (cf. Rizzolatti et al., 2002; Svensson, Lindblom & Ziemke, in press). In short, one is able to put oneself in another person's 'shoes' through some form of embodied simulation. Roughly speaking, this implies that one's own understanding of social interaction and another agents' mind is more than the exchange of communication signals.

## Neuroscience

Recent neuro-scientific findings suggest that such a resonance mechanism may rely on special kinds of visuo-motor neurons called *mirror neurons* (e.g., Gallese & Goldman, 1998; Gallese, Keysers & Rizzolatti, 2004). Mirror neurons are located in area F5 in the monkey brain and become activated both when *performing* specific goal-directed hand (and mouth) movements and when *observing* or *hearing* about the same actions (Kohler, et al., 2002; Rizzolatti et al., 2002). Because mirror neurons respond to both conditions, it has been argued that the mirror system functions as a kind of action representation, since it links 'action' and 'action-perception'. Consequently, this mirroring mechanism enables the agent to understand the meaning of the observed action by embodied simulation. Moreover, it has been speculated that the mirror system might be a basic mechanism necessary for imitation and 'mind-reading', i.e., attributing mental states to others (e.g., Rizzolatti et al., 2002; Svensson, Lindblom & Ziemke, in press). Taken together, the consideration of the mirror neuron system as the neurobiological underpinning of 'intercorporeality' and simulation theories as the basis of social interaction and mind-reading, provides significant examples of 'more' embodied views of social cognition.

## Social Psychology

Empirical evidence from social psychology has also demonstrated how social thought and judgments can be affected by bodily states, actions and motivations (cf. Barsalou et al., 2003; Niedenthal et al., 2005). Barsalou et al. (2003), e.g., have identified the following four kinds of social embodiment effects.

Firstly, *perceived social stimuli do not only produce cognitive states, but also bodily states*. For example, it has been reported that high school students who received good grades in an exam adopted a more erect posture than

students who received poor grades. Moreover, subjects primed with concepts commonly associated with *elderly* people (e.g., 'gray', 'bingo', 'wrinkles') exhibited embodiment effects such as slower movement when leaving the experimental lab, as compared to a control group primed with neutral words. Several other studies also show similar effects.

Secondly, *the observation of bodily states in others often results in bodily mimicry in the observer*. People often mimic behaviors, and subjects often mimic an experimenter's actual behavior, e.g. rubbing the nose or shaking a foot. Subjects also tend to mimic observed facial expressions, which is widely documented in the literature.

Thirdly, *bodily states produce affective states*, which mean that embodiment not only facilitates a response to social stimuli but also produces tentative stimuli. For example, subjects rated cartoons differently when holding a pen between their lips than when holding it between their teeth. The latter triggered the same musculature as smiling, which made the subjects rate the cartoons as funnier, whereas holding the pen between the lips activated the same muscles as frowning and consequently had the opposite effect. Moreover, bodily postures influence the subjects' affective state, e.g., subjects in an upright position experienced more pride than subjects in a slumped position.

Fourthly, *compatibility between bodily and cognitive states enhances performance*. For instance, several motor performance compatibility effects have been reported, in which subjects responded faster to 'positive' words (e.g. 'love') than 'negative' words (e.g. 'hate') when asked to pull a lever towards them.

These examples as well as other studies demonstrate that there is a strong relation between embodied and cognitive states in social interaction. In short, the bi-directional swapping between these states occurs automatically without any higher knowledge structure.

## Gesture

A significant embodied aspect of cognition is gesture, which constitutes a pan-human ability that may provide important information to the listener, since gesture offers speakers the means of expressing thoughts difficult to articulate in speech (Goldin-Meadow, 2003; McNeill, 1992). Accordingly, gesture is a natural part of communication, and even blind people produce gestures at the same rate, and in the same manner, as sighted persons (Goldin-Meadow, 2003). In addition, there is evidence which demonstrates that gesturing is a 'boon to the gesturer', and besides reflecting thoughts it might also *shape* thoughts (Goldin-Meadow, 2003). Gesturing may be a form of processing initial ideas that are shadowed but not hidden. As a result, gesturing functions as a vehicle of thought. Hence, gesture and speech complement, but do not compete, with each other (Goldin-Meadow, 2003).

It is important to notice that gesture has not only visual, but also kinaesthetic dimensions, and this phenomenological understanding may be crucial for how

the “body knows the world through the hand” (in Goodwin, 2000). In other words, gesture enables people to embody and communicate their thoughts in action.

### Linguistics

Iverson and Thelen (1999) demonstrate converging empirical evidence, which suggests that the systems of hand and mouth movements are not two separate systems. Rather, they should be viewed as an integrated communicative “speech-language-gesture” system that links the embodied origin of thought and cognition. Interestingly, the human homolog to area F5 in the monkey brain is Broca’s area, which has several crucial functions in language production (Arbib, 2005). Rizzolatti and Arbib (1998) suggest that the human mimetic capacity (cf. Donald, 1991) is a natural extension of the action-recognition mechanism based on mirror neurons, allowing human ancestors to communicate to a higher degree than other primates. Moreover, empirical results support a close coupling between language and action, and linguistic meaning is suggested to be grounded in bodily action (cf. Glenberg & Kaschak, 2002).

Bodily mimesis has recently been suggested to bridge the gap between language and embodiment (Zlatev, in press). Bodily mimesis is the *volitional* use of the body for constructing and communicating representations in the form of imitation and gesture. It is worth highlighting that the emergence of these bodily representations for the sake of *communication* might serve as the foundation for the phylogenetic development of a “human language” in form of a conventional symbolic system (Zlatev, in press). However, it is for future work to clarify the relation between mirror neurons, embodied simulation mechanisms, gesture, and the emergence of language.

### A Framework of Socially Embodied Actions

The disciplines discussed here offer highly complementary rather than alternative views on the role of embodiment in social interactions. By integrating these perspectives, we can obtain a deeper understanding of socially embodied actions. Another significant aspect of the proposed framework is that it integrates the ‘outside’, (third-hand perspective) and ‘inside’ (first-hand perspective) standpoints of the body in social (cognitive) interactions. From the ‘outside’ perspective, the framework demonstrates the role of the body in social interactions, by not separating thought from socially embodied actions, thus grasping the human sensitivity for bodily intentions in cognition. From the ‘inside’ perspective, it applies the empirical findings within neuroscience and related fields, offering a more thorough understanding of the phenomenological aspects and the underlying neural mechanisms that facilitate this human sensitivity of social interaction.

Based on the previous ideas and empirical findings, I have identified the following four fundamental functions of embodiment in social interaction:

- *The body as a social resonance mechanism.*

- *The body as a means and end in communication and social interaction.*
- *Bodily actions and gesture as a helping hand in shaping, expressing and sharing thoughts.*
- *The body as a representational device.*

**The body functions as a social resonance mechanism.** From an embodied perspective, there is no need to decode or represent embodied social stimuli to more ‘advanced’ or cognitive states since the bodily states in themselves actually are cognitive or affective states, as related work portrays. Furthermore, the social resonance mechanism does not only function in direct or online social interaction, but functions also in off-line interaction when the social stimuli are more abstract like in words and concepts. Hence, this first function portrays how cognitive and bodily states of the interacting partners are reflected in both themselves and in-between them.

**The body functions as a means and end in communication and social interaction.** Mirror neurons and the mirror neuron system are suggested to provide the linkage between ‘action’ and ‘action-perception’, and apparently, this implies that the body and its sensorimotor processes are ‘cognitive’ in themselves, and not only bounded by the brain. The great benefit of this action-understanding linkage, beside the parsimony of the account, is the inbuilt *dual* ability of grasping both the ‘what’ and ‘why’ aspects of the present action, i.e., what the action is about as well as catching the intention behind the movement. Different degrees of activation of and couplings with the mirror neuron system form a continuum between basic levels of action-understanding to more advanced ones, such as gestures and language. Although the current knowledge of the underlying mirror neuron mechanism is unable to explain in detail the whole complexity of human social interaction, it does shed light on how the interacting partners are able to share the communicated meaning in the dialogue. Hence, this second function offers a tentative explanation of that particular linkage, thereby unifying the ‘inside’ and ‘outside’ perspectives of socially embodied interaction.

**Bodily actions and gesture functions as a helping hand in shaping, expressing and sharing thoughts.** Besides speech, gesture is a significant (embodied) aspect of social interaction, which may provide important information to the listener, since gesture offers speakers the means of expressing thoughts difficult to articulate in speech. Through gesturing, we are able to generate and embody dynamical associations between different matters, which can offer new insights to the present situation or problem at hand. In addition, gesture sometimes serves as an explicit instance of the action-meaning embodied in speech, suggesting that hand movements are physical externalizations of the speaker’s ideas. Hence, this third function stresses how bodily actions operate both outwardly (inter-subjective) and inwardly (intra-subjective) in social interaction and cognition, in which our embodiment

(paradoxically) both constrains and enables the possibilities of expressive actions.

**The body functions as a representational device.** In addition to speech, there is the more controversial claim that the body also has representational properties, where certain kinds of gesture, portraying representational aspects, are the least provocative and most obvious examples of the body as an (external) representational device. The neurological roots of this ability might be the activity of the mirror neurons, since their linkage between ‘action’ and ‘action-perception’ might propose a kind of ‘action representations’ that are directly enacted in social interaction. Furthermore, since mirror neurons are able to compensate for missing ‘information’, and yet seem to ‘understand’ the goal of the action, it can be argued that the grasping of the action does not require a declarative understanding, since it is meaningful in themselves. Hence, the cognitive processes of social (cognitive) interaction are suggested, to varying extents, to be grounded in embodied ‘representations’ that have representational content. It should be noted, however, that we are not denying mental concepts as such, but questioning their organization, since they may be the result of and grounded in embodied interactions and not the underlying requirement for cognitive processes.

### Case Study

In order to illustrate the emerging framework’s potential, an instrumental case study was conducted. Due to the topic’s situated nature, the study was carried out in an everyday social activity ‘in the wild’ (cf. Hutchins, 1995). It offers additional empirical evidence in support of the previously addressed framework, by focusing on how we embody our thoughts in action through multimodal interactions such as gesture, speech, posture, and gaze.

The case study was carried out during a guided tour, in which I participated, at a ranch that maintains and preserves the Blackfeet’s herds of Spanish mustang horses. The ranch, named Blackfeet Buffalo Horse Coalition (BBHC), is situated outside Browning, Montana, in the US. The participants in the study were first and foremost the head of BBHC, Bob Black Bull, and a group of Swedish visitors, which all are familiar to handle horses. It should be noted that Bob does not speak Swedish, whereas the visitors understand English, but mostly communicate in Swedish within the group. The data collecting technique used was participant observation with video recording.

The unit of analysis is socially embodied actions in *co-regulated* interaction, but due to space limitations here I only present the analysis of a short episode that exemplifies the four fundamental functions of embodiment in social interaction and communication, which go far beyond the bounds of internal mental processes. Hence, the analysis considers both the spoken words and bodily actions, and the social situation at hand, which in many cases actually provide meaning to the embodied actions. The media used here, such as verbal descriptions and photographs, are quite ‘static’ and unable to capture the dynamics of motion and

intersubjectivity, which are better displayed in the actual video recording.

### The Filly Episode

The mustang horses at BBHC normally range freely in several herds on the prairie, but sometimes they have to be looked after. In this episode a couple of fillies have been dewormed and are kept in a paddock for surveillance. One of the fillies is lying on the ground, weakened by the medical treatment, and has made some unsuccessful efforts to rise. In addition, Bob has made some attempts to encourage the filly to rise, by patting her and clapping his hands, but his efforts have failed. Otherwise, the filly seems to be pretty alert. In short, the present task is to assist the filly to rise, and the following episode is illustrated by a few selected video frames.

The participants, besides Bob, are Dag (D), BoChief (BC), Peter (P), Catrin (C), and myself. A joint effort to help the filly is suggested, and C says<sup>1</sup> “you’ll have to take each other by the hands and together lift ...from underneath”. Bob is sitting on his heels beside the filly and initiates a lifting attempt, when BC and D enter the scene in order to assist. Together, they make an effort to lift the filly but they fail, seemingly because they do not really know how to cooperate, and consequently the un-regulated interaction, lasting about 5 seconds, comes to nothing (Figure 1). This means, the spoken words alone were not sufficient for co-regulation to emerge.



Figure 1: A sequence of the failed lifting attempt by Bob, BC and D (from left to right).

Therefore, they need to try again, and in order to explain how they should do it, P says: “take... take each others’ hands... from opposite sides” – and I add “from underneath”. At that point in time, D aligns his bodily position towards Bob’s, just for a short moment, which can be seen as a way of establishing a joint focus of attention and agreement of the task ahead. Then Bob turns around, and while pointing at C and looking at her, he says: “Catrin, come over here, we need you so we can pick her up”. While Bob utters the above sentence, he moves his right hand, which initially points at C, from her toward the filly, and this action is now being accompanied with his left hand and unites in a movement that can be interpreted as a kind of lifting gesture (Figure 2). The lifting gesture begins with him lowering his upper body and hands a little, and then he continues the whole gesture upwards. Thus, this gesture illustrates how he expresses and shares his thoughts in action as well as in speech. Moreover, by actually doing the lifting gesture he uses his body as a tool or representational device for the sake of communication.

<sup>1</sup> All quotes are translated from Swedish by the author.

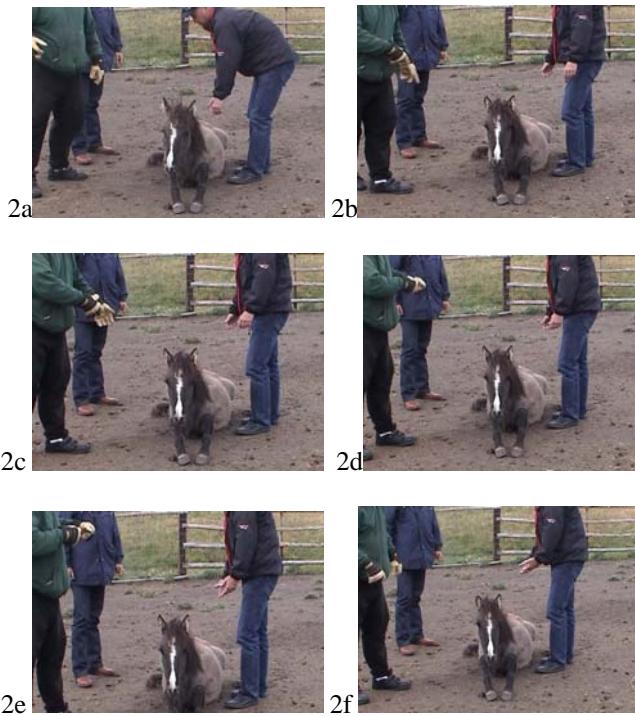


Figure 2: The first two frames (a-b) show Bob's shift in pointing from C to the filly, and the following ones (c-f) display Bob's lifting gesture and then D's accompanying gesture.

It is important to notice that the timing of the upward action of his hands and torso coincides with the last part of the utterance ("pick her up") and the particular forming of his hands (Figure 2b-2e) into a general gesture of the imaginary grip. Hence, it can be viewed as a way to assure D they should lift her up jointly, which is represented by the gesture that represents the close grip of each others' hands. Then (Figure 2e) before Bob lowers his hands, D who has been looking at Bob, starts to make a gesture of lifting, which is slightly different, as a way to share Bob's idea of how to lift, as well as showing that he actually has understood what to do in the next try (2e). However, D does not make the same representational gesture for lifting. Instead, he expresses how he should act from his perspective – how he should use his hands in the coming lift, whereas Bob's gesture rather reflects how to grasp each others hands jointly. In short, different perspectives of the lifting are expressed, but they both are ways to shape and externalize thoughts in socially embodied actions.

It should be noted that besides creating, showing and expressing thoughts, Bob's lifting gesture has kinaesthetic and phenomenological aspects. This means, besides the end result of the gesture, the dynamics in the action itself is a fundamental part of the cognitive function since the phenomenological experience of the bowing action are part of the action understanding in Bob as well as the action

recognition in D, via some kind of embodied simulation mechanism (cf. above).

The whole sequence in Figure 2 takes less than three seconds, in which D's gesture lasting only one second, but obviously it is enough, since when they are actually going to do the next lift, D repeats his lifting gesture, but now also towards BC while Bob is looking at them. This illustrates how the body functions as a social resonance mechanism and facilitates the understanding of another person's actions.

Finally, in the successful lifting of the filly, C joins the men and takes hold of the front of the filly, whereas Bob and D grasp each others' hands under the filly's belly, and when Bob utters "up" they are all co-regulated and as a result, the filly finally stands up and is able to join the other horses. This means, the previously uttered vocal suggestions how to 'assist' each other to lift the filly, were not enough for a co-regulated lifting action to emerge. Instead, when the participants were able to express and share their thoughts in cross-modal interaction, these socially embodied actions (including speech) were realized in the successful lift. All in all, embodied actions provide a 'helping hand' in the joint social interaction, and in a practical sense, gesturing actually enabled the men to embody their thoughts in actions and also their hands lent the filly a hand.

## Summary and Discussion

This paper has presented different views on the embodied nature of social interaction and joint action; resulting in a conceptual framework of how socially embodied actions are used in meaning-creating activity and interaction, which also has been illustrated in a case study. Thus, this paper contributes to extending the understanding of the social dimension of embodiment in current theories of embodied cognitive science.

However, the proposed framework is still work in progress, and needs further elaboration. Firstly, beside these four presented functions, the case study also reveals how crucial embodied actions are in the *emergence* and *engagement* of the shared social situation, actually 'lending a hand' for the shared situation to occur and be manifested. Secondly, there is a need to consider the different kinds of social interactions in communication (e.g., dyadic and triadic interactions), and then analyzing in what ways socially embodied actions are used in these meaning-creating activities. Thirdly, it is of importance to regard how embodied actions are integral parts of the always ongoing relational dialogue, that is, actions are always in relation to some prior information, and socially embodied actions do also play a fundamental role in this process. Finally, additional analysis of empirical evidence may provide further support for the above issues, which will subsequently be incorporated in the final framework (Lindblom, forthcoming).

To conclude, the framework suggests that our socially embodied actions (movement, touch, speech, gaze, posture, gesture, etc.) do not simply serve to *express* our internal

cognitive processes, but are themselves *part and parcel* of cognition.

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### References

Anderson, M. (in press). How to study the mind: In F. Santoianni, and C. Sabatano (Eds.). *Embodied Cognition and Perceptual Learning in Adaptive Development*. Cambridge Scholars Press.

Arbib, M. (2005). From monkey-like action-recognition to human language. *Behavioral & Brain Sciences*, 28, 105-167.

Barsalou, L. W., Niedenthal, P. M., Barbey, A. K. & Ruppert, J. A. (2003). Social embodiment. In B. H. Ross (Ed.) *The Psychology of Learning and Motivation*. New York: Academic Press.

Chrisley, R. & Ziemke, T. (2003). Embodiment. In *Encyclopedia of cognitive science*. London: Macmillan.

Clark, A. (1999). An embodied cognitive science? *Trends in Cognitive Science*, 3 (9), 345-351.

Dautenhahn, K. (1997). I could be you. *Cybernetics and Systems*, 25(8), 417-453.

Donald, M. (1991). *Origins of the modern mind*. Cambridge: Harvard University Press.

Frith, C. & Wolpert, D. (Eds.) (2004). *The neuroscience of social interaction*. Oxford: Oxford University Press.

Gallagher, S. (in press). Phenomenological and experimental contributions to understanding embodied experience. In T. Ziemke, J. Zlatev and R. Frank (Eds.), *Body, language, and mind: Embodiment*. Berlin: Mouton de Gruyter.

Gallese, V. & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in Cognitive Sciences*, 2(12), 493-501.

Gallese, V., Keysers, C. & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Sciences*, 8 (9), 398-403.

Glenberg, A. M. & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin & review*, 9(3), 558-565.

Goldin-Meadow, S. (2003). *Hearing gesture - how our hands help us think*. Cambridge, MA: Belknap Press.

Goodwin, C. (2000). Action and embodiment within situated human interaction. *Journal of Pragmatics*, 32, 1489-1512.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge: MIT Press.

Iverson, J. M. & Thelen, E. (1999). Hand, mouth and brain – the dynamic emergence of speech and gesture. *Journal of Consciousness Studies*, 6 (11-12), 19-40.

Johnson, C. M. (2001). Distributed primate cognition: a review. *Animal Cognition* 4, 167-183.

Johnson, M. & Rohrer, T. (in press). We are live creatures. In T. Ziemke, J. Zlatev, and R. Frank (Eds.), *Body, language, and mind: Embodiment*. Berlin: Mouton de Gruyter.

language, and mind: *Embodiment*. Berlin: Mouton de Gruyter.

Kohler, E., Keysers, C., Umiltà, M. A., Fogassi, V. & Rizzolatti, G. (2002). Hearing sounds, understanding actions: action representation in mirror neurons. *Science*, 287, 846-848.

Lindblom, J. & Ziemke, T. (2003). Social situatedness of natural and artificial intelligence: Vygotsky and beyond. *Adaptive Behavior*, 11(2), 79-96.

Lindblom, J. & Ziemke, T. (2005). Body-in-motion: broadening the social mind. *Proceedings of the XXVII Annual Conference of the Cognitive Science Society*, (pp. 1284-1289). Mahwah, NJ: Lawrence Erlbaum.

Lindblom, J. & Ziemke, T. (in press). Embodiment and social interaction: implications for cognitive science. In T. Ziemke J. Zlatev, and R. Frank (Eds.), *Body, language, and mind: Embodiment*. Berlin: Mouton de Gruyter.

Lindblom, J. (forthcoming). *On the embodied nature of social interaction and cognition* (working title). Doctoral dissertation, University of Linköping, University of Skövde, Sweden.

McNeill, D. (1992). *Hand and mind*. Chicago: Chicago University Press.

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S. & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review*, 9 (3), 184-211.

Núñez, R. (1999). Could the future taste purple? *Journal of Consciousness Studies*, 6(11-12), 41-60.

Riegler, A. (2002). When is a cognitive system embodied? *Cognitive Systems Research*, 3(3), 339-348.

Rizzolatti, G. & Arbib, M. A. (1998). Language within our grasp. *Trends in Neurosciences*, 21, 188-194.

Rizzolatti, G., Fadiga, L., Fogassi, L. & Gallese, V. (2002). From mirror neurons to imitation: facts and speculations. In A. N. Meltzoff and W. Prinz (Eds.), *The imitative mind – development, evolution, and brain bases*. Cambridge: Cambridge University Press.

Sinha, C. & Jensen de Lopez, K. (2000). Language, culture and the embodiment of spatial cognition. *Cognitive Linguistics*, 11, 17-41.

Svensson, H., Lindblom, J. & Ziemke, T. (in press). Making sense of embodied cognition. In T. Ziemke, J. Zlatev, T. and Frank R. (Eds.) *Body, language, and mind: Embodiment*. Berlin: Mouton de Gruyter.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.

Tomasello, M., Carpenter, M., Call, J., Behne, T. & Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *Behavioral and Brain Sciences*, 28, 675-735.

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & review*, 9(4), 625-636.

Ziemke, T. (2003). What's that thing called embodiment? *Proceedings of the 25<sup>th</sup> Annual Meeting of the Cognitive Science Society* (pp. 1305-1310). Mahwah, NJ: Lawrence Erlbaum.

Zlatev, J (in press). Embodiment, language, and mimesis. In T. Ziemke J. Zlatev, and R. Frank (eds.), *Body, language, and mind: Embodiment*. Berlin: Mouton de Gruyter.