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Proceedings of the Annual Meeting of the Cognitive Science Society

Title

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Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 27(27)

ISSN

1069-7977

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Publication Date

2005

Peer reviewed

The Role of Embodiment in Situated Learning

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Abstract

The concept of activity is central to situated learning theories, but activity has largely been considered an exclusively sociocultural process in which the body only plays a minor role. In embodied cognition research, on the other hand, there is an increasing awareness that mind and body are inextricably intertwined and cannot be viewed in isolation. Findings in the field of cognitive neuroscience provide additional evidence that cognition is tightly linked to perception and action. This paper aims to shed a light on the role of the body in situated learning activity by integrating the different perspectives of situated learning and embodied cognition research. The paper suggests that, like individual human conceptualization and thought, situated learning is in fact deeply rooted in bodily activity. In social interactions the body provides individuals with a similar perspective on the world, it functions as a means of signalling to others what cannot (yet) be expressed verbally, and it serves as a resonance mechanism in the understanding of others.

Introduction

The paradigm shift from cognitivism (e.g. Pylyshyn, 1990) to situated cognition (e.g. Levine & Resnick, 1993; Clancey, 1997) holds important implications also for educational practice and research. Traditionally, learning has been considered an exclusively internal process. This conviction has found its expression in concepts such as ability, talent, and intelligence, and is a consequence of, as Barab and Plucker (2002) put it, “the separation of the learner from the learning context” and “the isolation of the body from its mind” (p. 165). Contextual aspects have been believed to play an insignificant role in learning, and teaching practices have therefore focused largely on transmitting content into the mind of people. The traditional view has been challenged in recent years by both educators and scientists who have started to consider learning and knowledge acquisition in terms of interactions and meaning-construction within a sociocultural context. Traditional theories, it has been argued, are insufficient to explain the ways individuals learn and make use of knowledge within and outside schools.

Situated learning is a theoretical framework in which scientists strongly emphasise sociocultural aspects of cognition and learning. The underlying assumption is that the knower cannot be separated from the known leading to a position in which knowledge and learning are considered the result of *social activity* in context (e.g.

Brown, Collins & Duguid, 1989; Barab & Plucker, 2002; Greeno, 1998; Lave & Wenger, 1991).

The Body in Situated Learning

The notion of (social) activity is one of the cornerstones in situated learning theories, but for a variety of reasons, the focus in situated learning is almost exclusively on sociocultural aspects of learning activity such as social interactions and tool use. Activity often appears to be conceived of as a cognitive process which is somehow detached from the body, making the body just an additional tool for the subject and not an integral part of human cognition. Despite an increasing awareness of the body in different areas of cognitive science (e.g. Roth & Lawless, 2002; Wilson, 2003), researchers interested in the nature of learning and knowledge appropriation have, with few exceptions (e.g. Clancey, 1995; Drodge & Reid, 2000), largely sidestepped the issue of embodiment in learning. While strongly emphasising the interpersonal and artefact-mediated nature of cognition and activity, they have been less concerned with the body itself and its role in human thinking. Very often, the body is “just” another factor, briefly acknowledged and mentioned, but in fact understood and analysed very little.

During recent years, however, the bodily basis of processes such as social interaction and tool use has become a key concern for a growing number of researchers in the field of neuroscience (e.g. Adolphs, 2001; Johnson-Frey, 2004; Maravita & Iriki, 2004; Rizzolatti, Fadiga, Fogassi & Gallese, 2002). Promising findings within this field, and the growing interest in the body as the primary unit of analysis in other areas of cognitive science, have opened new opportunities to enhance our knowledge about the body and its role in learning (cognition). By looking more closely at how the body is involved in learning activity processes such as tool use and social interactions we can get a better understanding of human cognition in general and of the body itself.

This paper aims to bring together the (on the surface completely) different perspectives on learning and activity in the theoretical frameworks of situated learning and embodied cognition by discussing the sociocultural dimension of embodied cognition, i.e. how the body is involved in processes such as social interaction and tool use as learning and activity in situated learning theories are considered to be linked to practice and social exchange.

The two next sections describe in some detail the theoretical frameworks of situated learning and embodied cognition research, with the overall focus on social learning activity, which is characterised by social interactions and different kinds of tool use.

Situated Learning

Situated learning theories are largely based upon and related to the philosophies of situated cognition where a key theme is that cognition is for action (e.g. Clancey, 1997; Suchman, 1987; Wilson, 2003). This philosophy goes directly against the functionalist belief in mind-body dualism according to which a person's ideas, beliefs and knowledge are autonomous and disconnected from (bodily) experience. Being widely accepted by a large number of researchers in the various fields of cognitive science, this position had, not surprisingly, far reaching and lasting implications for education and educational theorising as well (Kirshner & Whitson, 1997). Situated learning theories generally criticise the traditional philosophical position of dualism by strongly emphasising the active and situated nature of learning.

The theoretical framework of situated learning is currently characterised by a variety of perspectives and viewpoints on the issues of learning, activity, and knowledge appropriation, as researchers and scientists interested in the complexities of learning and human cognition are active in a wide range of research fields (e.g. Brown et al., 1989; Lave & Wenger, 1991; Rogoff, 1990). In spite of the widely differing approaches to learning and activity there is, nonetheless, a broad scientific consensus to view and describe learning in terms of activity and participation in a community of practice, which clearly reveals the close relationship of situated learning and its historic precursors of cultural-historical psychology (e.g. Vygotsky, 1932/78), Activity Theory (e.g. Leontiev, 1978; Galperin, 1992a), and early 20th Century American psychology and sociology (e.g. Mills, 1940).

Cultural-Historical Traditions

The influence of especially the cultural-historical approach to learning and activity is strikingly apparent as learning and activity are viewed as processes that are completely interactive and interdependent. One of the cornerstones in the cultural-historical approach is the idea of human cognition being the result of cultural rather than natural processes, that is, to describe and to explain higher mental processes such as learning and communication in terms of socially and culturally mediated activity.¹ Connecting cultural, social, and mental processes, the cultural-historical approach has clearly also some implications for education and educational research. Instead of merely focusing on the individual, attention has been moved to actual learning activities in which the child is engaged in a framework of guided participation (Rogoff, 1990). Vygotsky (1932/78), for instance, considered learning a process of activity in which

¹The sharp distinction between cultural and biological processes, however, is being questioned by many researchers (e.g. Rogoff, 2003).

human mediators and the use of psychological tools play central roles. The idea of higher mental processes being a function of and created through socially meaningful mediated activity is fundamentally opposed to traditional theories according to which mental activity is superior to both neural and bodily activity in the sense that one has first to think about what to do next before an activity can be performed. Given the underlying philosophy of interdependency between thought and physiological processes, the notion of activity has not unsurprisingly become the main unit of analysis and key to understanding human cognition.

Activity is described as a process that is mediated by other people's behaviour, material tools, and psychological tools (e.g. language). The use of psychological tools, for instance, is said to develop in the course of social interaction with other people. Fundamental to the cultural-historical view on activity has been Leontiev's (1978) idea to describe behaviour by means of different levels of analysis, which are presented in the concepts of *activity*, *action*, and *operation*, and corresponding, *motive*, *goal*, and *conditions*. In this sense, activity is a socially meaningful unit of behaviour in which a variety of action sequences is structured around shared goals and conditions. The concept of meaningful activity was, according to Galperin (1992a), introduced to clarify that the object of psychology is not an internal process or the physiological reactions to stimuli but rather the activity of a subject. Galperin (*ibid.*) considered the concept of meaningful activity, nonetheless, to be somewhat troublesome as it was given "a psychological description with regard to only one concept – motivation" (p. 42). Galperin argued that by ignoring the object-related operational content of activity it was largely overlooked that mental activity in fact is highly dependent on external, object-related activity.

Galperin's theory (1992b) is generally based on the assumption that mental object-oriented activity is the result of initially materialised object-oriented activity, that is, broadly speaking, the physical manipulation of objects constitutes the basis of human thought. This assumption suggests that mental processes are deeply rooted in sensorimotor activity, a perspective which is highly consistent with embodied cognition research. Furthermore, Galperin's approach to learning and activity bears also many similarities to situated learning theories. Learning is described by Brown et al. (1989), for instance, as a process in which observation, guidance, and practice are essential elements, and which is characterised by transparent access to learning strategies and methods; this is an assumption that is quite consistent with Galperin's view on learning. Given the strong emphasis on materialised activity, i.e. the idea of the body being an essential part of mental activity, and the apparent similarities that exist between his ideas and situated learning, Galperin's approach might provide an important link between situated learning and embodied cognition theories. Galperin appears to have been one of the first scientists to recognise and to explicitly point out the embodied nature of object-oriented activity.

Apprenticeship and Participation

In situated learning, embodiment aspects of human activity and cognition have received little interest, despite the large focus on activity in context. Drawing heavily on historical ways of learning and teaching such as craft and trade apprenticeships, scientists in the research area of situated learning frequently use different kinds of apprenticeship concepts to describe and explain situated and sociocultural aspects of learning and knowledge appropriation. The different conceptions of apprenticeship and participation such as *guided participation* (Rogoff, 1990), *cognitive apprenticeship* (Brown et al., 1989), and *legitimate peripheral participation* (Lave & Wenger, 1991) are largely based on ethnographic (anthropological) studies of learning and everyday activity, which have been instrumental in revealing how different schooling is from activities in the daily domain of life. From the very beginning, most attention has been directed at how people learn in the context of participation and guidance. Learning, generally, is viewed as a process of activity in (a community of) practice and, accordingly, characterised by a group of people trying to accomplish some activity (their practise) while cooperating with each other in a community of practice.

Clearly, the interdependency of learning and activity is one of the central tenets in situated learning, but the body as an integral part of activity is barely mentioned since activity most of the time is simply described as a process in which the culturally and socially based relation between the environment (different kinds of tools, other persons) and the subject is of central interest. In embodied cognition research, on the other hand, sociocultural aspects of social interaction and tool use have received a lot of attention in recent years, but these aspects are largely discussed in the more general context of human thinking and cognition (e.g. Clark, 1997; Roth & Lawless, 2002; Wilson, 2003).

Embodied Cognition

The body and its role in thinking has been reconsidered by an increasing number of researchers in various research areas such as neuroscience (e.g. Rizzolatti et al., 2002) and philosophy (e.g. Clark, 1997). Instead of reducing the body to an input-output device and explaining cognition in terms of mental symbol manipulation, researchers and scientists in embodied cognition now seek to emphasise the complex interplay between body and mind, between the agent and the world which it is part of and functions in. Despite differing ways of conceptualising embodied cognition, however, there seems to exist a number of features that generally are associated with the embodied cognition approach (Wilson, 2003).

The basic assumption is that cognition is a continuous process with changing boundaries and, thus, much more than what takes place within the individual mind. Cognition, accordingly, cannot be understood without taking contextual aspects such as tool use into consideration which is a perspective very similar to situated cognition and learning. Recent findings also suggest

that cognition is deeply rooted in and inextricably intertwined with bodily activity. Most researchers interested in the embodied nature of human cognition have usually discussed the issues of cognition and activity in more general terms, but the findings in this field are also of particular relevance to educators and educational research.

The Body in Social Situations

Human beings are social beings and the interactions and relations with other individuals are an essential part of their lives. Through social interactions with others people share informations and contacts and, in the words of Lave and Wenger (1991), become part of a community of practice. Social interaction, in other words, is a rather complex process and full of meaning, requiring people to find ways to communicate and to understand each other. Through the years, social psychologists have documented well diverse deeply social interactive phenomena such as mimicry and action imitation, but these phenomena have not been discussed from an embodiment perspective (Semin & Smith, 2002). In embodied cognition research, in contrast, social aspects of embodied cognition have not received much attention which is somewhat surprising as the embodied nature of human cognition in recent years has been addressed from a broad range of perspectives in many areas of cognitive science (Lindblom & Ziemke, in press).

However, lately, it has increasingly been shown that embodied cognition is in many aspects a very social process, and that embodied social processes such as mimicry and imitation are significant for social relations as they help people connect, making it possible for them to communicate and to understand each other (e.g. Barsalou, Niedenthal, Barbey & Ruppert, 2003). Most theories describing the social dimension of embodied cognition are largely based on the idea of cognition being the result of activity simulation in specific brain circuits. Such activity simulations appear to provide not only fast learning mechanisms where new actions are learned through imitation, but also seem to play an important part in decision making as well as in emphatic and cooperative behaviour (e.g. Barsalou et al., 2003; Hesslow, 2002). These assumptions are supported by an increasing number of neuro-chemical and neuro-psychological studies which indicate the existence of a motor-resonant mechanism in humans. These studies have shown that thinking about an action to some degree activates the same brain areas as when the activity is performed in real. That has led a growing number of researchers (e.g. Rizzolatti et al., 2002) to suggest that a matching system between action execution and action observation might constitute the basis of communication and action recognition and, hence, of a shared understanding between individuals (e.g. a man who watches his wife take the car keys knows immediately that she is going by car to the grocery store).

Another important aspect of embodied social interaction is gestures as they help the speaker express ideas and thoughts (Goldin-Meadow, 2003). Gestures are an

important part of human cognition given the fact that no culture has been discovered yet in which people do not gesture while talking. According to Goldin-Meadow (2003) and Wilson (2003), gestures offer a substantive view on the mental processes of people as they often carry a person's knowledge about a certain topic. In a study conducted by Evans and Rubin (1979 in Goldin-Meadow, 2003), for instance, it has been illustrated that gestures displayed by a group of children repeatedly revealed (non-verbalised) knowledge about a game that the children explained to an adult. It has also been shown that children often produce so-called gesture-speech mismatches, an effect by which gestures and speech convey conflicting information. Goldin-Meadow (2003) argues that children producing such mismatches are more likely to benefit from instruction as they, at this stage, are "open to, and thus on the precipice of learning (p. 40). However, she also pointed out that gesture-speech mismatches seem to be an important step towards mastery as children not displaying such mismatches were more likely to generalise knowledge than did children who in fact went through this developmental stage (Alibali & Goldin-Meadow, 1993b in Goldin-Meadow, 2003). This implies, according to Goldin-Meadow (*ibid.*), that gestures not only *reflect* learning, but to a considerable degree also *contribute* to it.

This assumption is highly consistent with, for example, Roth (2002) who suggested that gesturing is not only about communication with others but also serves an important (cognitive) function for the speaker as it helps her think and make things clear and understandable. A study conducted by Roth (*ibid.*) shows, for instance, that the use of gestures in combination with tools not simply replaced language as a mean of understanding, but was in fact an important step towards the proper use and development of required scientific concepts.

Tool Use as Embodied Activity

In recent years, many studies have also investigated the role of tool use in human thinking and it has become clear that tool use is a crucial aspect of human cognition (e.g. Hutchins, 1995; Preston, 1998; Rambusch, Susi & Ziemke, 2004). For quite a long time, tool use, that is, knowing what an object is and how it can be used, has been believed to be the result of mental processes. Tool use, accordingly, can at earliest occur at a stage where mental representations and thought have evolved. A heavily contrasting view is presented by, e.g. Lockman (2000) according to whom tool-use behaviour already can be observed in infants' attempts to detect affordances of objects and surfaces in the environment. In his view, the trial-error behaviour displayed by children of this age is the basis of tool use as this kind of behaviour is an opportunity for children to explore and understand their environment on a sensorimotor level. Tool-use behaviour, in these terms, is a stepwise learning process in which tool use and insight emerge gradually over time and arise from small children's attempts to relate objects to other objects and surfaces while detecting affordances based on available perceptual information.

That means, tool-use behaviour is not simply the result of innate structures that in time lead to sudden insight, but is rather a process of continuous embodied activity. Lockman's (2000) perspective is consistent with *ecological* viewpoints on cognition and object manipulation, i.e. perception is an active process and all information necessary can be found in the environment (cf. Gibson, 1979). That means, you know how to use a chair because the chair affords a particular behaviour, not because you make use of a mental categorisation that tells you what a chair is and how it can be used. In other words, there is no action without perception, knowledge evolves only through perceiving and acting. Action and manipulation, accordingly, seem to be fundamental for acquiring knowledge about and the use of objects.

Recently, ecological positions have received significant support from studies in the field of neuroscience. These studies have not only illustrated the existence of a motor-resonant mechanism, but also a close relation between perception of an object and the manipulation of the same object. Regions responsible for grasping and manipulating actions, for example, are active during tool naming and viewing, and during identification actions which are related to certain tools (Johnson-Frey, 2004). This mechanism, in other words, seems to provide us with the means to identify and represent objects with respect to their function, i.e. the type of interaction they allow. This mechanism, broadly speaking then, does not simply specify perception and action aspects of an object but – in the Gibsonian sense – the particular relationship between agent and environment. The categorisation of an object, thus, is not only about learning and representing its visual characteristics, it is more importantly about understanding its meaning (its use) (Grafton, Fadiga, Arbib & Rizzolatti, 1997).

Conclusions

Being closely related to the research area of situated cognition, situated learning theories are, at least at a first glance, strongly opposed to dualistic assumptions according to which the mind can be described and understood in isolation from the body and its environment. However, the body and its relation to activity have mainly been ignored in situated learning theories, apart from a few notable exceptions. The aim of this paper has been to take a closer look at how the body is involved in learning activities as being discussed in the theoretical framework of situated learning. Cognition, and learning in particular, are seen as processes that are situated as they emerge through interaction between agent and environment. Much emphasis has, subsequently, been on sociocultural aspects, making social interactions between individuals and the active use of structures in the environment a vital part of situated learning activity. That is, activity in situated learning is a process that can be described in terms of social interactions and tool use. This has been particularly evident in the various apprenticeships concepts where learning and doing are considered processes that cannot be separated and seen in isolation.

Embodied cognition research has provided an additional picture of the situated nature of situated-learning activity by putting emphasis on the close and mutual relationship between thinking and doing from a different point of view. The underlying assumption in the theoretical framework of embodied cognition is that cognition arises from bodily interactions with the world and is, thus, grounded in and linked to sensorimotor activity. Situated-learning activity, from this point of view, is not only a purely sociocultural process but also a process that is the result of bodily interactions in the world. Recent findings in neuroscience have, for instance, provided solid evidence that our social behaviour is largely influenced by bodily activity and the way in which we categorise and use specific kinds of tools. Situated learning, in other words, is a process that is deeply rooted in sensorimotor activity as communication, social understanding, and tool use are linked to perception and action. The body in situated learning activity, accordingly, (1) makes possible a shared understanding of the world between individuals, (2) functions as means for communication and social interaction, and (3) is the basis of human thought.

There is increasing evidence that suggests that a *shared understanding between individuals* is grounded in human (and non-human primates') ability to recognise and simulate the actions of con-specifics. Even though two individuals always have different perspectives on things, because they are two different individuals, the body makes possible a shared understanding between them. The body here functions as a reference point, that is, even though two people look at, for instance, a chair from two different perspectives, both can relate to that particular chair as both know from bodily experience what a chair is. To put it differently, the experience of object-related actions is not only essential for an individual understanding of objects but also for a shared, social understanding of them.

The body is frequently used in *human communication and social interaction*. For instance, a person pointing at a chair has the intention to draw the attention of another person to this chair to make it clear what s/he is referring to. The body, here, is signalling something to the receiver. Obviously, this role of the body is closely related to the previous one as the body, in turn, makes it possible for the receiver to understand the pointing behaviour of the sender. Gesturing is also a process in which the body is actively involved and which serves the cognitive function of communication. Activity in a community of practice, thus, is not only sociocultural in its content, but is also linked to sensorimotor activity. That is, the ability to recognise and simulate the actions of others makes it possible for us to understand each other and to find a common ground from which we can communicate with each other.

The body, as *the basis of human thought*, is critically involved in processes such as decision making and problem solving as mental simulations of actions are not only an integral part of human thinking but more importantly also are tightly linked to sensorimotor activity.

Moreover, bodily activity (that is, gestures) is an important tool in developing and understanding abstract concepts and knowledge. That is, human thought cannot be reduced to symbol manipulation or social exchange, but is inextricably intertwined with perception and action.

Open Questions and Future Work

With the discovery of the action-perception matching system, expectations are running high in the scientific community and one cannot help thinking that a new era is about to begin in cognitive science. Having the possibility to find answers for questions regarding the nature of different kinds of mental abilities, of course, such a thought is quite compelling. However, it seems that there is still a long way to go and researchers might be well advised to be cautious and to avoid direct claims about the action-perception matching system as the key to meaning, communication and understanding. Many experiments have been conducted on monkeys, and even if there is increasing evidence for the existence of a similar system in humans, we cannot be sure that there are not other crucial differences after all. Rizzolatti et al. (2002) also pointed out that the transformation from goal-understanding to goal-oriented activity has remained an open question. That means, even though it appears that the action-matching system is fundamental for an understanding of actions, researchers do not have an answer to how this understanding is transferred into a corresponding behaviour.

The aim of this paper has been to discuss the role of the body in situated learning by integrating situated learning and embodied cognition research on sociocultural aspects such as social interactions and tool use. An important and necessary next step is a more concrete translation and integration of findings within embodied cognition research to the theoretical framework of situated learning. In the approach introduced by Galperin (1992b), both situated learning and embodiment perspectives are integrated, which makes his approach a good candidate to provide a link between the theoretical frameworks of situated learning and embodied cognition. This paper can be considered a first step towards such an integration as it shows that situated learning activity is tightly linked to embodied sensorimotor activity. In the future, sociocultural processes such as social interactions and tool use need to be discussed in much more detail from an embodiment perspective to gain a more profound understanding of cognition and learning. A more detailed discussion might also represent a significant step towards practical applications of this knowledge in educational practice and research.

References

- Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology*, 11, 91–130.
- Barab, S. A. & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist*, 37(3), 165–182.

- 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*. San Diego, CA: Academic Press.
- Brown, J. S., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32–42.
- Clancey, W. J. (1995). A tutorial on situated learning. In J. Self (Ed.), *Proceedings of the international conference on computers and education, Taiwan*. Charlottesville, VA: AACE.
- Clancey, W. J. (1997). *Situated cognition: on human knowledge and computer representations*. Cambridge: Cambridge University Press.
- Clark, A. (1997). *Being there. Putting brain, body, and world together again*. Cambridge, MA: MIT Press.
- Drodge, E. N. & Reid, D. A. (2000). Embodied cognition and the mathematical emotional orientation. *Mathematical Thinking and Learning*, 2(4), 249–267.
- Galperin, P. I. (1992a). The problem of activity in soviet psychology. *Journal of Russian and East European Psychology*, 30(4), 37–59.
- Galperin, P. I. (1992b). Stage-by-stage formation as a method of psychological investigation. *Journal of Russian and East European Psychology*, 30(4), 60–80.
- Gibson, J. J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.
- Goldin-Meadow, S. (2003). *Hearing gestures. How our hands help us think*. Cambridge, MA: Harvard University Press.
- Grafton, S. T., Fadiga, L., Arbib, M. A. & Rizzolatti, G. (1997). Premotor cortex activation during observation and naming of familiar tools. *Neuroimage*, 6, 231–236.
- Greeno, J. (1998). The situativity of knowing, learning, and research. *American Psychologist*, 53, 5–26.
- Hesslow, G. (2002). Conscious thought as simulation of behaviour and perception. *Trends in Cognitive Science*, 6(6), 224–242.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.
- Johnson-Frey, S. H. (2004). The neural bases of complex tool use in humans. *Trends in Neuroscience*, 8(2), 71–78.
- Kirshner, D. & Whitson, J. A. (1997). *Situated cognition: social, semiotic, and psychological perspectives*. Mahwah, New Jersey: Lawrence Erlbaum Associates.
- Lave, J. & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press.
- Leontiev, A. N. (1978). *Activity, consciousness, and personality*. Hillsdale: Prentice Hall.
- Levine, J. M. & Resnick, L. B. (1993). Social foundations of cognition. *Annual Review of Psychology*, 44, 585–612.
- Lindblom, J. & Ziemke, T. (in press). Embodiment and social interactions: implications for cognitive science. In T. Ziemke, J. Zlatev & R. Frank (Eds.), *Body, language, and mind. Vol 1: Embodiment*. Mouton de Gruyter. (to appear in 2005)
- Lockman, J. J. (2000). A perception-action perspective on tool use development. *Child Development*, 71(1), 137–144.
- Maravita, A. & Iriki, A. (2004). Tools for the body (schema). *Trends in Cognitive Science*, 8(2), 79–86.
- Mills, C. W. (1940). Situated actions and vocabularies of motive. *American Sociological Review*, 5, 904–913.
- Preston, B. (1998). Cognition and tool use. *Mind and Language*, 13(4), 513–517.
- Pylyshyn, Z. W. (1990). Computation and cognition. In J. L. Garfield (Ed.), *Foundations of cognitive science*. New York: Paragon House.
- Rambusch, J., Susi, T. & Ziemke, T. (2004). Artefacts as mediators of distributed social cognition: A case study. In *Proceedings of the 26th annual meeting of the cognitive science society*. Mahwah: Lawrence Erlbaum.
- Rizzolatti, G., Fadiga, L., Fogassi, L. & Gallese, V. (2002). From mirror neurons to imitation: facts and speculations. In A. N. Meltzoff & W. Prinz (Eds.), *The imitative mind. Development, evolution, and brain bases*. Cambridge: University Press.
- Rogoff, B. (1990). *Apprenticeship in thinking – cognitive development in social context*. New York: Oxford University Press.
- Rogoff, B. (2003). *The cultural nature of human development*. New York: Oxford University Press.
- Roth, W.-M. (2002). From action to discourse – the bridging function of gestures. *Journal of Cognitive Systems Research*, 3, 535–554.
- Roth, W.-M. & Lawless, D. V. (2002). How does the body get into the mind? *Human Studies*, 25, 333–358.
- Semin, G. R. & Smith, E. R. (2002). Interfaces of social psychology with situated and embodied cognition. *Cognitive Systems Research*, 3(3), 385–396.
- Suchman, L. (1987). *Plans and situated action: the problem of human-machine communication*. Cambridge: Cambridge University Press.
- Vygotsky, L. S. (1932/78). *Mind in society. The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wilson, M. (2003). Six views of embodied cognition. *Psychonomic Bulletin and Review*, 9(4), 625–636.