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## THE EMBODIMENT OF MIND

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**Abstract:** *This paper examines the involvement of the body in cognitive activity. On the basis of the survey of various manifestations of human behavior, it is concluded that the body is intrinsically involved in cognition. Theoretically the question is how to conceptualize this in the framework of cognitive theory. Several possible conceptualizations are examined. In particular, I argue against the two-tier model which conceptualizes the role of the body in terms of a secondary appendage to an essentially orthodox representational-computational account. The involvement of the body in cognitive activity is further viewed in conjunction with the situatedness of cognition in the world. The embodiment of mind is related to the topics of experience and consciousness.*

**Key-words:** *embodiment; cognition and body; representationalism; critique of cognitive theory; metapsychology.*

### A PREFATORY PERSONAL NOTE

This paper is about the involvement of the body in cognition. At first glance, such a topic may look quite far removed from those that

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comprise Marcelo Dascal's work, but actually this is a station in a long intellectual path which was triggered by my very first encounter with Marcelo. The key term in this story is "pragmatics". I remember exactly the first time I ever heard this term, which eventually turned out to be central throughout my own academic work. The occasion was a course Marcelo gave in the Department of Philosophy at the Tel Aviv University in 1970. Marcelo was a young lecturer, and I a student of linguistics and philosophy. It was my fascination with language that led me to psycholinguistics, and subsequently to formal studies in psychology. As I turned from student to independent researcher I arrived at two major realizations. The first had to do with the primacy of the pragmatic relative to the semantic. As the years passed, more and more did I come to appreciate the significance of the messages conveyed by Marcelo, long before the pragmatic perspective got to be shared by many. The other realization was that one cannot separate the study of language from that of cognition at large. Specifically, I discovered that the problematics pertaining to the relationship between semantics and pragmatics actually reoccurs, in different modes and variations, in all other facets of human cognition. Together, these realizations led me to a project with which I was deeply involved for more than a decade and which culminated in *The Representational and the Presentational*, a monograph published in 1993. The project consisted of, on the one hand, a critique of the representational-computational view of mind, for many years the dominant paradigm in the cognitive science, and on the other hand, proposals for alternative theoretical frameworks for the study of mind. Inspecting practically all facets of human cognition, I realized that there is a series of factors that the cognitive establishment disregards for their not being "pure". Following my linguistic background, I referred to these factors as "non-semantic"; now I would call them "not-purely cognitive". These factors, of which the body is one,

appear to be crucial for the conduct of mental activities - language, perception, memory, learning, thought processes. Orthodox cognitive psychologists might admit these factors as secondary, but it seems that these factors are the most basic, primary ones defining the very essence of natural human (as opposed to artificial computer) intelligence. Like the pragmatic aspects of language, which are more basic than the purely semantic ones, so are the contextual and actional aspects of the other faculties of mind. The present paper, which focuses on the body, is sequel to the aforementioned project. Its having led to stations that are so distant from the point of origin actually mark the force of the intellectual vehicle to which I was introduced by Marcelo. Coupled with my hope that the ideas presented here will meet Marcelo's sympathy, are my sentiments of appreciation, gratitude and good wishes for the further travels on the pragmatic path.

### 1. THE EMBODIMENT OF MIND

This paper examines the involvement of the body in cognition. With this, it examines the place of considerations pertaining to the body in cognitive psychological theorizing. Until not many years ago, cognitive scientists did not talk about the body at all. Both dominant conceptual frameworks in the field – the representational-computational view of mind (RCVM) and what is considered to be the main alternative to it, connectionism, characterize cognitive performance in terms of abstract representations and computational operations applied upon them. The two frameworks differ in the representational structures and the computational operations that they postulate. By RCVM, the representations are symbolic and they exhibit various well-defined formal properties; correspondingly, the operations applied upon them are ones of symbol manipulation. In connectionism the representations

are not well-defined and the computational processes do not involve symbols. Further, in contrast to orthodox representational models, connectionist ones are intrinsically dynamic and they assume no clear demarcation between representations and computational processes. For these reasons, connectionist models are often said to be non-representational. For the present context, this issue is not important. What is, rather, is the fact that in both RCVM and connectionism it is assumed that cognitive activity is characterized in abstract terms (symbols in the one case, activation patterns in neural-like networks in the other) and that the material substrate in which the cognitive system is implemented is deemed irrelevant and is outside the scope of the investigation.

I do not subscribe to this view. A comprehensive examination of the various aspects of the phenomenology of human cognitive performance – language and thought processes, perception and memory, motor activity and affect, development and consciousness – has led to me to conclude that abstract representations cannot serve as the substrate of human cognition. The critique and a proposal for a non-representational picture of mind are presented in Shanon (1993a). The present discussion assumes that picture of mind and the alternative framework for cognitive research that it entails.

## **2. BODY AND BRAIN – PRELIMINARY TERMINOLOGICAL CLARIFICATIONS**

The representational disregard of the body is usually defended by reference to the distinction between hardware and software as employed in computer science. The brain is regarded as hardware, the mind (or cognition) as software. Actually, however, the two issues need not be the same. In order to appreciate this a key distinction has to be borne in mind – that between the body and the brain.

It is an utter truism that without the brain no cognitive activity is possible. However, just as the student of artificial intelligence is engaged with the development of programs and need not be concerned with computer hardware, the student of natural intelligence, it is maintained, can study cognition while disregarding the body. (see, for example, Putnam (1973); Newell (1980); Vera and Simon (1992)). With this, it is often claimed that even though human beings are made of flesh and blood and computers are made of silicon chips and electronic circuits, functionally both are – in principle – of the same type.

What I would like to do here is underline the distinction between body and brain. The body which is the topic of our discussion here is not the neurophysiological substrate in which cognition is realized. The body is that biological organism with which each human being is acquainted directly and which he or she considers his or her own. Existentialist European philosophers – notably, Merleau-Ponty (1962) and Sartre (1957) have referred to this as the *phenomenological body*. Manifestly, the phenomenological body includes as salient parts hands, arms, legs, face. The aim of the present discussion is to argue that this phenomenological body is, indeed, involved in cognitive activity and that in consequence, cognitive theory cannot ignore it.

Before I go on with the consideration of the body as just defined, let me note that I do share the representationalist's disregard of the neurophysiological substrate of cognition. The difference between the representationalists and myself is couched in the two readings of the word "body". RCVM identifies the body with the neurophysiological system, and in dismissing the body it marks a division between the cognitive and the neurosciences. While, like the orthodox representationalist (but perhaps not the connectionist), I hold that the neurophysiological body is not relevant to the study of mind, I believe that the body in its second, phenomenological sense plays a crucial role

in cognitive activity and that cognitive theory cannot disregard it. It goes without saying that as far as this phenomenological body is concerned human beings and computers are categorically different.

Here a comment regarding connectionism is in place. The connectionist stance *vis à vis* the brain is different from that of RCVM. Indeed, one of the first motivations for the advent of connectionist models was the belief that cognition should be modelled in terms that could be, at least in principle, tied with the brain. Unlike symbols in classical semantic representations, neural-like networks and activation dynamics might be tied in such a fashion (Rumelhart and McClelland (1986); McClelland and Rumelhart (1986)). Perhaps the more human-oriented subscribers to the connectionist paradigm, like orthodox representationalists, are not concerned with the brain but definitely there are lines of research in connectionism where the bringing together of the computational models with brain research is of paramount importance (see, for instance, Abeles (1982); Amit (1989)). Yet, as far as the phenomenological body is concerned, the connectionist position is not different from that of RCVM.

The following discussion presents my case for the embodiment of cognition. The paper is divided into two main sections. The first section surveys empirical evidence in support of the thesis that cognition is embodied. The second section discusses how the embodiment of cognition should be conceived within the framework of a general theory of mind.

### 3. EMPIRICAL OBSERVATIONS

In the argumentation against the disregard of the body two issues are to be noted. On the one hand, there is the issue of bodily activity (motor performance) and its modelling in representational terms. On the other hand, there is the issue of the involvement of the body in cognitive activity. These two issues are completely different and it is crucial to keep the difference between them in mind. Since the prime subject matter here has to do with the second issue, let me begin with the first.

#### *Knowing How*

In the literature, both psychological and philosophical, the relevance of the body is usually made by marking the contrast between two types of knowledge – *knowing-that* and *knowing-how*. The former is manifested in one's knowledge of facts, in one's retrieval of memories, in one's specifying information, in one's being familiar with objects and situations; the latter is manifested in one's apt execution of skilled performance. As pointed out by Ryle (1949), the two types of knowledge are distinct and independent of one another. First, we note that it is often the case that people can skillfully execute motor tasks without being able to specify the knowledge implied by the execution of these tasks. After all, most people who swim or ride bicycles cannot articulate the rules that govern the activities they perform. Furthermore, people may accomplish a motor task perfectly but when asked to specify details pertaining to it, furnish answers that are wrong. Thus, Papert (1980) observed that verbal specifications that riders of bicycles give of the directions in which one should bend one's body in turning are opposite to the directions the same riders take in actual riding (for a general, philosophical discussion of this tacit knowledge see Polanyi (1962), (1966)). Further still, knowing the rules that generate an activity does not

at all guarantee that one can actually perform this activity. Being able to articulate the rules that govern swimming is, of course, no evidence that one can actually swim. Moreover, not only is articulate knowledge not necessary for performance, it may even hinder it (see Polanyi (1962); Dreyfus (1979); Dreyfus and Dreyfus (1986)). Thus, conscious reflection of how one performs an acrobatic act is very likely to result in a disruption of the execution of the task in question.

All the patterns noted are very simple, yet they are instructive. By RCVM, none of them should occur. On this view, behavior – all behavior – is achieved by means of underlying cognitive activity consisting in the manipulation of symbols in mental representations. In this respect there should not be any difference whatsoever between talking, remembering or problem solving and any motor activity or skilled performance. From this, several corollaries follow. First, the specification of the knowledge that is manifested by one's behavior should have been always possible. Second, since the knowledge being specified is a prerequisite of the activity in question, such specification should not have been dependent on any manifest activity. Third, by RCVM one should not expect people to furnish specifications that counter the actual performance being produced. Fourth, possessing all the knowledge that characterizes a task should be sufficient for mastering that task. Thus, knowing about an activity should entail knowing how to perform that activity. And fifth, by no means should knowledge interfere with task execution. The fact that all the patterns that, by RCVM, should not have occurred do, in fact, occur, indicates that this view of mind is fundamentally flawed.

The foregoing observations underline the limitations of representational models in accounting for bodily activity. The problems indicated are special cases of a general problem, namely, the failure of representational theories for domains that are not paradigmatically



cognitive. Apart from motor activity, such domains include affect, motivation and volition. As noted, however, in the present discussion the primary topic of interest to us is different. Here we are concerned with what are considered to be paradigmatic cognitive performances. The point to be argued is that even these facets of human behavior cannot be studied without taking the body into consideration. Thus, following is a survey of a variety of cognitive activities in whose execution the body seems to play an important, and at times crucial, role. This being the case holds against the principled disregard of the phenomenological body.

*Bodily Involvement in Cognitive Activity*

Let us start with a simple, everyday observation. The observation pertains to the skill of typing, and I will present it from my own (but far from idiosyncratic) experience. I am a very good typist – I type quickly without looking at the keyboard. But then, ask me to specify the position of the letters: What, for instance, is the sequence of keys in the middle row of the keyboard? I cannot tell you. I am not able to take a pencil and reproduce the letters and other characters as they are placed on the keyboard – line after line, from left to right. This is curious. Surely, I know where all characters are. If I did not, how could I place my fingers on the keyboard and type? While I cannot reproduce the layout of the keyboard in the manner noted, I can nonetheless specify where any given letter is on it. In generating such a specification I am likely to do either of two things. I may move my hand in the air, draw it to a certain position in the space in front of me, hit an imaginary key and then answer “here”. Alternatively, I may type not a letter but a word, one that includes the queried letter as one of its constituents. I will observe the fingers as they tap in the air, perhaps I will slow down and repeat the

tapping once or twice and then say what the position of the queried letter is. It is in executing the bodily movement that my knowledge comes into being.

One does not have to be a typist to appreciate this phenomenon. Try the following: How many syllables are there in the word “representationalism”? How many letters? These are remarkably difficult questions if one attempts to answer them in isolation, outside the context of actual linguistic production. But, in practice, people do answer such questions, and they do so well and quite easily. What they do is something analogous to what I do when asked about the placement of characters on the keyboard. They start uttering the word “Rep-re-”... they may accompany the uttering by counting on their fingers, and then say “Ah, seven”. The pronunciation of the entire word is not mandatory; some pronunciation, however, is.

As a last preliminary observation, let me cite Marcel Proust’s *A la recherche du temps perdu* (Proust (1963)), the novel which is actually a monumental study of the phenomenology of human memory. In Proust’s conception of memory, the involvement of the body is pivotal. The following episode is an attestation of this:

[...] [A]s I moved sharply backwards I tripped against the uneven paving-stones in front of the coach-house. And at the moment when, recovering my balance, I put my foot on a stone which was slightly lower than its neighbor, all my discouragement vanished and in its place was that same happiness [...] And almost at once I recognized the vision: it was Venice, of which my efforts to describe it and the supposed snapshots taken by my memory had never told me anything, but which the sensation which I had once experienced as I stood upon two uneven stones in the baptistery of St. Mark’s had, recurring a moment ago, restored to me complete with all the other sensations linked on that day to that particular sensation. (pp. 898-900).

Turning to the scientific literature, let me cite Zajonc and Marcus (1983) who observed that intellectual performance is often associated with overt motor behavior: the moving of the eyes, the moving of the lips, scratching one's knee, knotting one's hair (Pasteur is said to have done this when struggling with scientific issues). The moving of the eyes may be explicated by the activation of the cerebral hemisphere involved in the cognitive task in question (see Gur, Gur and Harris (1975)), the moving of the lips is surely related to subvocal verbalization, but what about the other motor activities? These seemingly insignificant movements suggest that so-called pure cognition cannot be separated from one's body. Like the typist who has to activate his or her fingers in order to indicate the location of letters on the keyboard, the solver of abstract puzzles activates hands, lips and perhaps other parts of the body as well.

Experimental findings corroborate these observations. Murray (1966) compared the learning of lists of letters by subjects who just looked at the letters, whispered them, or said them aloud. Best recall was found under the last condition. Similarly, subvocalization was found to help in mental arithmetic (Fryer (1941)) and in reading comprehension (Braddeley, Eldridge and Lewis (1981)). Negative evidence is revealing as well. It is not at all easy to nod one's head vertically and at the same time say "no". Wells and Petty (1980) corroborated this observation experimentally: they asked subjects to execute hand movements non-compatible with what the subjects were asked to say; the task proved to be extremely difficult. Zajonc and Marcus (1983) further marked the common concordance between what one plays on a musical instrument and the movements one generates while playing. The playing of high notes, for example, is associated with an ascending, not a descending, movement of the eyebrows.

The production of bodily movements in the course of cognitive performance is most salient in talking. Notoriously, people “talk with their hands”. As pointed out by Freedman (1989), there is no such thing as motionless speech – bodily activity during spoken discourse is a universal phenomenon. In order to appreciate this, follow Gergen (1985) and try uttering a sentence such as “Hello, how are you?” without accompanying the sentence with the usual gestures, facial expressions and body posture. Your expression (if you do at all succeed in producing it) will appear highly artificial, if not aberrant. The empirical investigations of McNeill (McNeill (1975); McNeill and Levy (1982)) as well as of Kendon (1984), corroborate these observations and ground them in a broader theoretical framework. These investigations reveal that speech and gesture are highly intertwined and that there is an on-going synchronicity between them.

The motor activity involved in cognitive performance need not be peripherally expressed. This is argued by the motor theory of thinking (for a review see Cohen (1986)). This theory, which was already proposed by several scholars at the turn of the century, maintains that mental activity requires motor activity, especially when no external sensation is available. A modern variant of this theory proposes that all acts of will involve activation of the motor system and that the experience of voluntariness arises only from motor activity, even if not peripherally expressed. Thus, using electromiographical measurement, McGuigan and Rodier (1968) discovered increased speech motor activity in subjects who read during auditory distraction as compared to ones who read in silence. Hardyck and Petrinovich (1970) found that subjects who kept their laryngeal region relaxed while reading exhibited worse comprehension than subjects who kept their forearms relaxed or ones who did not relax any muscle. Further, it seems that experimentally

induced muscle tension can improve performance on a variety of mental tasks (for further details, see Cohen (1986)).

The body seems to play a role also in sensory perception. As conceived by RCVN, perception involves the body only inasmuch as the sensory organs are the channels by which information is detected. Arguing against this standard view of perception has been the main thrust of the work of James Gibson (see Gibson (1966), (1979)). One of Gibson's most basic observations is that organisms perceive the world as they move about in it. Yet, even though organisms move, the world is perceived as stable. At the same time, the organism appreciates the fact that it itself is moving. Hence, Gibson concludes that what organisms perceive are patterns that stay invariant as they move. Thus, the perception of the external world is intimately linked with the perception of one's own movement. For what is perceived to remain stable and coherent, the organism has to constantly take into consideration its own location, the position of its body, and its on-going movement in space. One sees the environment not with the eyes but with the "eyes-in-the-head-on-the-body-resting-on-the-ground." (Gibson (1979), p. 205).

Experimental findings support these conclusions. Remarkably, when people are placed in room-like constructions in which the walls and ceiling glide over the floor, people who see only the moving walls and ceiling but not the stationary feet and floor experience the illusion of being moved forward and backward (Lishman and Lee (1973)). For other pertinent experimental findings, the reader is referred to the studies by Warren on the passing through doors and the climbing of stairs (Warren (1984); Warren and Whang (1987)).

The involvement of the body in perception has also been invoked in the domain of language. One of the most important theories of speech perception is the motor theory of speech perception. By it, the perception of speech is achieved by reference to motor patterns

employed in speech production. Indeed, in a strong version of the theory, speech perception is said to actually involve subvocal activation of the speech organs (see Halle and Stevens (1964)).

The intimate link between perception and bodily movement also finds support in neurophysiological studies. In a classical series of experiments, Held and Hein (1963) hooked newborn kittens to an apparatus so that one kitten could move more or less normally whereas the second was carried in a gondola and, except for head turning and leg movement inside the gondola, all its gross movements were ones that were transmitted by the movements of the first kitten. The two kittens in the pair were reared in darkness until the active member developed sufficient strength and coordination to move the apparatus. Pairs of kittens spent several hours a day in the experimental condition where they were exposed to identical visual stimulation; the rest of the time they were kept with their mothers and litter mates in unlighted cages. After an average of about 30 hours in the apparatus the active members of all tested pairs exhibited normal behavior in several visually guided tasks; the passive members did not. The latter did, however, develop normal behavior within days after they were allowed to run about in a normal environment. In a similar vein, Held and Freedman (1963) found that human subjects moving actively showed adaptation to prism goggles whereas subjects moving passively did not. The moral of these studies is that active body movement is essential for the normal development of the perceptual system.

The body's involvement is also noted when there is neither overt bodily movement nor manifest dealing with the external world. Thus, consider the following description of the beginning of a standard day in a person's life; the description is taken from Johnson (1987):

...You wake *out* of a deep sleep and peer *out* from beneath the covers *into* your room. You gradually emerge *out* of your stupor, pull yourself *out* from under the covers, climb *into* your robe, stretch *out* your limbs, and walk *in* a daze *out* of the bedroom and *into* the bathroom. You look *in* the mirror and see your face staring *out* at you. You reach *into* the medicine cabinet, take *out* the toothpaste, squeeze *out* some toothpaste, put the toothbrush *into* your mouth, brush your teeth *in* a hurry, and rinse *out* your mouth. At breakfast you perform a host of further *in-out* moves-pouring *out* the coffee, setting *out* the dishes, putting the toast *in* the toaster, spreading *out* the jam on the toast, and on and on (pp. 30-31).

As indicated by the many emphasized terms in the text (all marked as such in the original) the relationships of putting things in containers and of taking them out permeates the manner by which we structure our experience and express it in language. As indicated in the text, not only physical actions but also perceptual and mental ones are conceived and expressed in terms of these relationships. The patterns of relationships between objects and containers constitute one of a number of what Johnson refers to as “kinesthetic image-schemas”. These schemas define basic patterns by which people, as embodied agents, move about in the world and manipulate objects in it. Other image-schemas that Johnson specifies pertain to the moving from sources through paths towards targets and goals, the making and breaking of links, and the relationships holding between wholes and their parts. These patterns are so common and their use is so straightforward that usually people hardly pay any attention to them. Yet, the manifestation of these patterns is so pervasive that Lakoff and Johnson ((1980); see also Lakoff (1987)) have argued that they define the very foundations of both language and cognition. In particular, Johnson and Lakoff suggest that both our encoding of the world and its expression in words are rooted in metaphors pertaining to bodily movement and action. Terms pertaining to bodily movement and action also feature as primitives in

the orthodox frameworks of semantic representation of Schank (1973) and Jackendoff (1976).

The kinesthetic image-schemas are involved not only in the coding of experience and its expression in words but also in the mental processing associated with the terms in question. As pointed out by Lakoff and Johnson (1980) (see also Jackendoff (1976), Johnson (1991)) basic patterns of inference are based on the application of the bodily schemas. In other words, a valid inference is one that is consistent with the patterns of action enabled by the bodily schema. As such, the image-schemas present a new basis for the modelling of human reasoning, one that contrasts with that presented by the different systems of formal logic. The theory of mental models proposed by Johnson-Laird (1983) is also founded on the basic insight that rather than being governed by rules of logical deduction, human reasoning is accomplished by means of acts akin to those people concretely execute in the world. Johnson-Laird talks of the world, not the body, but as will be noted below, there is a systematic analogy between the roles of the body and the world in cognition.

Lastly, let me cite the wonderful essay *Talk's body* by Sudnow (1980). In it, the author reflects upon the act of piano playing. This he does in writing, that is – while composing text. This composition, whose subject matter is the keyboard of the piano, comes into being while acting upon another keyboard – that of the typewriter (hence the subtitle of the book: *A meditation between two keyboards*). The main thrust of the book is to show that just as the body plays a key role in the playing of the piano, it plays a key role in the development of intellectual ideas and their expression in written language. Typing is not a peripheral act in which full-fledged developed thoughts are expressed via an external medium. Rather, it is an act which is part and parcel of the very process of thought and creation.



#### 4. THEORETICAL CONSIDERATIONS

Empirical data such as those surveyed in the first part of this paper indicate that the body is intricately involved in cognitive activity. We have seen this to be the case even in conjunction with performances that seem to be purely mental and that *prima facie* should not require any bodily involvement. Given this state of affairs, the theoretical question arises as to how the role of the body in cognition is to be conceptualized. In this second part of the paper I shall present several possible approaches for such conceptualizations. These will be tied to more general issues pertaining to the nature of mind and its scientific study.

##### *The Two Tier Approach*

The first possible approach is to acknowledge the involvement of the body but retain as much as one can the representational picture of pure cognition. In light of data of the type surveyed above, it would be admitted that the body is involved in cognitive activity, yet it would be argued that no radical changes in cognitive theory are implied. Specifically, one would hold that basically, cognition is governed by representational-computational principles and would relegate the bodily involvement to a secondary tier constituting an appendage to the basic representational one. The modified theory would thus consist of two tiers. The first tier would be the classical representational one – it would be modelled in strict representational-computational terms with no reference to the body. The second tier would take the outputs of the first tier and subject them to modifications due to the consideration of the body and its influence.

This two-tier approach is encountered throughout the literature in various domains in which the purist stance in cognition has been

criticized (see, for instance, Thagard (1986)). The most notable case is that of language. Confronting effects due to pragmatic factors, the orthodox representationalists, who beforehand altogether ignored pragmatics and denied its relevance to semantic theory, generally come to concede that pragmatic factors may indeed play a role in verbal behavior. This they do, however, without changing the basic, primary semantic core of the cognitive theory. Paradigmatic cases of the two-stage approach are the early accounts of metaphors and the so-called indirect speech acts (e.g., Searle (1979), (1975), for metaphor and indirect speech acts, respectively) in which these two non-standard linguistic types are analyzed as modifications or derivations of the presumably standard types that correspond to them – literal meaning and direct speech acts, respectively.

As noted at length in Shanon (1993a), the two-tier (or two-stage) approach permeates contemporary cognitive science. This approach can be valid only if several conditions are met. First, the components or types of processing associated with the first tier should define what is generally the case whereas those associated with the second tier should pertain to less frequent, more specialized cases. Second, on independent grounds, the former should be shown to be more basic than the latter. Third, a clear demarcation line between the two types of components or processes should hold. If the first two conditions are not met, then it would be more reasonable to reverse one's perspective and to regard the components or processes pertaining to the second tier as basic. Furthermore, if the third condition is not met, then for considerations of parsimony, one could dispense with the two-tier conceptualization, and avoid the clear division between types or stages. In Shanon (1993a) I show that empirically none of the three conditions hold. Hence, the two-tier conceptualization is unwarranted.

*The Primacy of the Body*

In the two-tier conceptualization the body plays a significant role in cognition, but its status is secondary. Against this conceptualization, I argue that the involvement of the body is primary and that it cannot be accounted in terms that retain a basic representational core.

The characterization of primacy is based on several considerations. First are the *conceptual* ones: Bodily activity cannot be reduced to symbolic processing. As we have seen, knowing-how cannot be reduced to knowing-that. Second are *phenomenological* considerations: Whereas there are cases in which symbolic activities depend on bodily involvement, the converse need not be the case – bodily activity does not seem to be dependent on symbolic activity. The third set of considerations are *procedural* ones: Often, in order to perform cognitive tasks one has to involve the body and overall, when the body is thus involved cognitive performances may be executed faster and better than when it is not. Fourth are *developmental* considerations: The early stages in child development are characteristically sensory and motor. Progressively behavior gains independence from the body and it is only in later stages of the child's development that symbolic activity of the pure cognitive type is encountered. Indeed, this progression seems to define a basic line of human ontogenetical development; as noted below, it is central in the two most important theories of development in psychology – Piaget's and Vygotsky's. *Evolutionary* considerations may also be invoked. These considerations are commonsensical, but telling: The body is shared by both human beings and lower organism, pure cognition is not. Given the universal assumption of biological evolution, it is natural to view cognitive performances that are grounded in bodily activity as simpler and more basic than ones which are not; the converse ordering (which, in fact, is implied by RCVM) is counter-intuitive. Finally, there are

*systemic* considerations: It appears that the basic principles governing the performance of the cognitive system are akin to skills associated with action in the external world – with moving about in the world, with the manipulation of objects, and with the interaction with other human beings (for related discussion, see Kolers and Roediger (1984) and Kolers and Smythe (1984)). To these last considerations I shall return towards the end of this paper.

By way of concrete example, let me consider a phenomenon already noted in the first part of this paper, gestures in verbal communication. This phenomenon is especially telling because language is the one cognitive performance usually conceived to be the best suited for the representational-computational analysis. Manifestly, gestures are part and parcel of human verbal discourse. Why is this case? Is this just a peripheral phenomenon, a non-essential accompaniment to basic processes which are symbolic? My own view (shared by Kendon (1984)) is that the intimate link between words and gestures is due to the latter playing a basic role in cognition. This is the case because gestures present a more direct reflection of the workings of the mind than speech does. Both the structural characteristics of gestures and their ontogenetic development support this assessment.

Structurally, the holistic and global nature of gestures is especially noteworthy. The gesturing hand depicts many characteristics of the content it conveys: the movement involved in action, its magnitude, dimensions and direction, its force and rhythm, and so forth. An illustrative example presented by McNeil (1975) is that of the gripping motion made when one talks of a knife. This gesture depicts not only the fact that a knife was gripped, but also the shape of the knife and the manner in which it was held. This example is telling for it shows that one gesture can convey what discursive speech will have to express in many words. Indeed, gestures often present details that speech does not (and

cannot) convey. Furthermore, gestures have a temporal aspect. Often, gestures convey simultaneously contents that speech can express only in succession. Indeed, gestures may anticipate speech and convey what the speaker will express verbally only later. The remarkable speed of gestures marks their condensed informativeness, and suggests their psychological primacy and directness; for pertinent empirical findings the reader is referred to the works cited above as well as to Kendon (1972), (1975), (1984).

While the gestures of the hand are perhaps the most salient bodily expression manifested in talking, they are not the only one. As pointed out by Freedman ((1989), see also Bateson (1972)), the entire body manifests the intent of what is being said. Indeed, the posture of the body and the way it moves reveal a person's basic stance in the world. Open legs often mark a wish for openness, rigid bodily posture goes with rigidity of personality, the movements of the arms and the hands reveal a person's mode of interaction with other people – how much this person is in control, how receptive and responsive he is, how flexible. For interesting empirical observations as well as clinical applications highlighting the metaphoricity of body posture and movement, the reader is referred to Dascal (1991), (1992).

In sum, the intimate involvement of the body in verbal behavior as it manifests itself in gesture, posture and movement seems to be due to these expressions being direct reflections of the basic dynamics of mental activity. This dynamics is not fixed in well-defined, distinct units in which message and medium are differentiated. Rather, it is holistic, it does not involve a distinction between message and the medium of its articulation, and it is rooted in the agent's action in the world.

Developmental patterns also indicate that gestures pertain to very basic modes of behavior. Gestures, and especially early gestures, are very much tied to one's actual acting in the world. Early gestures are

derived from actual physical acts. Thus, pointing and reaching gestures seem to be derived from movements in which real objects are grasped and manipulated (Carter (1975)). In this vein, children's first gestures are enactments of their own actions. Indeed, early gesturing is conducted with the entire body or with those parts of the body that are standardly involved in the actions in question (e.g., speaking of running, one moves one's feet). As indicated by McNeil (1975), adult gesturing also exhibits such patterns. This is especially the case when adults attempt to communicate what they cannot articulate in speech. Indeed, in such cases, the role of gestural expression becomes paramount. Similar observations regarding the paramount role of gestures and motor activity in the development of human communicational behavior are encountered in Vygotsky (1981) and in Werner and Kaplan (1963).

Taking a broader perspective, we note that the assessment that cognitive development is rooted in the body is a key tenet of Piaget's developmental psychology (see Piaget (1954), (1970)). Piaget characterizes human intellectual development in terms of a succession of distinct stages. The first of these is the sensory-motor stage. In it, the child's cognitive activity is tied to perception and motor performance. Only at subsequent stages does cognitive activity gain independence from the body. In fact, the increased autonomy of cognitive behavior relative to the body is, according to Piaget, one of the key principles underlying ontogenesis. Significantly, this is also the case in the theories of development of Vygotsky and his followers in the Soviet school of activity theory (see, for instance, Vygotsky (1962)). Proposals along this line are also made in the more recent work of Eleanor Gibson and her colleagues who study development in light of the insights of ecological psychology (see, Gibson (1969); Gibson, (1982); Gibson and Spelke (1983)).

Similar patterns are encountered in guided, non-spontaneous development as it appears in particular (as contrasted with general human) tasks. Referring to the phenomenon of instruction and learning, I would like to cite an example reported by Serafine (1988). It has to do with the traditional ways in which Native American fiddle music was taught to young boys. The boy was made to sit next to the fiddler and their legs were tied together. As the fiddler was playing and stomping the beat the boy's leg would go up and down too. Only after the boy has had much practice at stomping will he be given the instrument to hold. This example beautifully counters the representational model of learning and teaching whereby these two processes involve the passing of information from the knowledge store of one person to that of another. This conceptualization, which is central in contemporary cognitive science, may be traced to the first account of a psychological experiment in Western civilization, namely, the encounter between Socrates and the slave in Plato's *Meno*; for a conceptual critique of this view the reader is referred to Shanon (1984a).

*Embodied Cognition in Context*

The body has primacy over pure cognition, but the body is not the only factor to have such a primacy. Throughout Shanon (1993a) I argue that the body is one of a set of what I call *non-semantic factors*. These factors are ones that the program of pure cognition disregards, sets out of its proper scope of investigation, and, in effect, cannot handle. The other factors in the set are the physical world, the social other, non-cognitive psychological faculties such as volition, motivation and affect, and temporality.<sup>1</sup>

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<sup>1</sup>In Shanon (1993a) I also include the factors context and medium, but as I explain there, these two factors and those indicated in the body of the text

Taking a broader theoretical perspective, two things should be noted. First, the various factors are not unrelated – there are analogies and interdependencies between them. Second, in their totality the factors define one common matrix. This matrix is the foundation for a non-representational picture of mind which, to my mind, offers the basis for an alternative framework for the study of human cognition.

In this paper I focused on the embodiment of cognition, but the observations and arguments made here are very similar to ones encountered in conjunction with another property of the human cognitive system, namely, situatedness. Just as it is embodied, human cognition is situated in the world. As noted, the world is one of the other members of the set of non-semantic factors. In the contemporary cognitive-psychological literature situatedness is usually associated with the physical world. However, in line with Vygotskian thought, the world in which human beings are situated is not only physical but also social. And indeed, complete analogy is to be found also with another member of the set of non-semantic factors, namely, the social other.

Bearing these analogies in mind, let me tie the primacy of the body with two basic issues having to do with the nature of human cognition and the way cognitive inquiry should be carried out. I refer to the issue of what the basic features of the human cognitive system are and to the issue of the locus of cognition.

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here pertain to two different conceptual levels. The factors indicated here are phenomenologically given whereas context and medium are theoretical defined. Overall, my view is that cognition takes place in the space (in the mathematical sense) of context-medium which, in turn, is constituted by the meeting of the cognitive system with the body, the physical world and the social other as well as with the non-cognitive facets of mind. Now, I think values and ethical considerations should also be included in the set of non-semantics factors.



By the RCVM, the basic capability of the human cognitive system is the carrying out of computational operations applied upon either symbolic structures. My view is different – by it the basic capability in question is being and acting in the world. This view is rooted in the philosophies of Heidegger (1962) and Merleau-Ponty (1962); for calls for the application of these ideas in cognitive science the reader is referred to Winograd and Flores (1986), Dreyfus (1991), Varela, Thompson and Rosch (1991) and Hendriks-Jansen (1996).

The two-faced feature of being and acting in the world is intrinsically tied to the body. It is by virtue of the body that one is in the world. As the phenomenological philosopher Merleau-Ponty (1962) has pointed out, the body is the meeting space between me and the world. It is with my body that I meet the world, and it is through the body that the world meets me. Furthermore, the body defines the very space in which cognitive agents live. It circumscribes the milieu of one's habitation in the world and it constitutes the measure of the world for one. Language attests to this very clearly. Indexicals such as "here" do not refer to a determinate position in an external co-ordinate space, but rather lay down a person-specific system of co-ordinates. The body is, to use Merleau-Ponty's words, "the union of the subject and of the world". Many philosophers have claimed that we know the world by means and in terms of forms of thought, categories and various conceptual structures, but, in fact, we know it by means of our body and in terms of its activities in the world. The body is the first given, that which defines the particular identity of each one of us, and that by which everything else exists and has meaning.

In the foregoing comments I have spoken of the physical world, but similar observations apply to the social world as well. My encounter with the social other is also by virtue of the body – my body and that of him or her. I come to know other human beings and other human

beings come to know me through the bodily contact of the senses. In normal social activities the key contacts are the visual and the auditory, but in the course of human development the first contact (that of the baby and the mother) is tactile and also olfacto-gustatory.

In line with the discussion of language above, I would like to underline one specific sensory manifestation of cognition, namely, language. By the standard representationalist perspective, the concrete realization of language in phonology is of not much significance. Indeed, most cognitive scientists – and with them philosophers of mind – have focused their attention on syntax and semantics, pragmatics and logic. By contrast, phonology never seemed to be of great philosophical significance. As argued in Shanon (1993b), I think this view is misguided. Phonology makes linguistic expressions concrete, a feature that has two important ramifications. First, language becomes interpersonal. Second, the cognitive processes associated with language gain concreteness, and thus, linguistic expressions may be subject to activities akin to those human beings execute with real, physical objects. In the way expounded here this manner of performance is a basic feature of the human cognitive system.

Let me turn to the locus of cognition. Both RCVM and connectionism regard the locus of cognition as internal. Cognitive activity takes place either in an underlying, covert mental or computational space or in the more basic (relative to manifest cognition) brain and neurophysiological substrate. By contrast, I maintain that the locus of cognition is external. In the present context the term “external” should be read as “non-internal”. In saying that the locus of cognition is external I mean that the arena of cognitive life is where self and world meet. In psychology, the external view of cognition has been most forcefully advocated by James Gibson and his followers in the school of ecological psychology (see, for instance, Gibson (1979)). More recently,

and on the basis of independent lines of reasoning, it has also been argued for in philosophy, notably by Putnam (1988).

*The Body and Experience*

We have noted that the body plays an important role in cognitive behavior, we have characterized this role as primary and we have observed that this is in line with some basic features of the human cognitive system. We can go further and ask why this is actually the case – why is it that the body along with its siblings in the set of non-semantic factors are so fundamental? I reckon that in addressing myself to this question I am posing a more speculative question. Of course, one could have left the question aside and just stipulate that the non-semantic factors are basic, appreciate the structural analogies and the functional interrelations amongst them, and leave it at that. Yet, intellectually, the question does remain – why this set?

To my mind, in order to reach a suitable answer to these questions, one has to appreciate what the science of psychology is about. In the hundred and twenty years of its existence as a modern scientific discipline, psychology has changed its conception of itself. It has been argued that psychology is the science of behavior, the science of human information processing, the science of knowledge and its various manifestations. Some have also been arguing that eventually psychology is nothing more than the manifestation of (high level) brain activity. I think all these views are wrong. The alternative view I espouse is that psychology is the science of *human experience*. As noted by William James (1912/1958) many years ago, experience is a phenomenon in the world. As such it is a topic for objective scientific investigation. Psychology is the discipline whose goal is to chart the domain of experience, define its structures and dynamics, mark the regularities and the lawful

interrelationships in this domain, and attempt to characterize them all in terms of a small number of basic principles (for guidelines for such an enterprise the reader is referred to Shanon (1989)).

My view is that experience is characterized by three key features. I think all of these are crucial and I not inclined to order them. For obvious practical reasons (the linearity of written discourse) the following presentation adopts a specific order; conceptually, however, I would impose none. The first feature I shall note is *subjectivity*. Experiences (and with them, consciousness) pertain to an agent, and this agent is “me”. There are no mental events out there in the world without them being the acts performed by a particular cognitive agent. Further, all mental events to which I have access are products of my own mind; they are, in other words, “mine”. The psychological phenomenology of different people may be (is, I believe) governed by the same basic principles, but the experiences of each person are inherently his or her own and only he or she is privy to them. The second feature is *materiality* or *concreteness*. Experiences are not abstract. In this respect, too, they contrast with the basic structures postulated by RCVM. These latter are formal and abstract. The structures and processes of human cognition, I maintain, are not such (see Shanon (1993b)). Thirdly, experience is *felt* or *sensed*. It has, in other words, that quality which is not reducible to any formal representation or computation which philosophers often refer to by the term *qualia*.

Now, it seems to me that the reason the body plays such a key role in our cognitive life is that the body is what makes these three features of experience possible. Unlike the philosophical mind, the metaphysical soul, the theological spirit and the “scientific” computations, the body is material. And each body pertains to one and only one person. As noted by Merleau-Ponty, the body is not an object like any other in the world. It is. Furthermore, there are no selves or minds or

cognitive systems without a body. And finally, being (biologically) alive, the body is defined by sensed being (see Shanon (1990)).

Note that embracing the view that psychology is the science of experience one gains a perhaps unexpected bonus – the division between the internal and the external world becomes less crucial. Where is experience? No, it is not confined to the mental realm. Some of what I experience is indeed “mental” – thought sequences, mental images, dreams, inner voices, musical tunes that one may silently hum to oneself. But most of what one experiences is not confined to the inner domain – so much of it pertains to sensation and perception. But I do not wish to get bogged down by the (to my mind futile) question of whether perceptions are in the head or outside. Perceptions pertain to the world of experience, and the world of experience is constituted by the meeting of cognizing agents with the world. It is not confined to either the internal or the external (for similar views, see James (1912/1958)). Indeed, it defies the distinction for, as argued above, even the “internal” experiences gains their special flavor as experiences by virtue of their similarity to the paradigmatic “external” experiences: Thought sequences are akin to publicly uttered verbal utterances, mental images are akin to visual percepts, and so forth.

*Consciousness: Cognition Without the Body*

Against all that has been said here it may be argued that there are cases in which one performs cognitively without the body being involved. Obviously this is true. But this empirical fact need not detract from the theoretical stance espoused here. In fact, just the opposite is the case.

By way of clarification, I would like to focus on a phenomenon I have studied extensively, namely, thoughts that spontaneously pass

through people's minds and of which they are aware. Evidently, such *thought sequences* take place privately without any manifest bodily activity. Even overt verbal production is not involved. What I would like to point out is that even here, the embodiment and situatedness of cognition is assumed. What happens when trains of thought pass through one's mind? An inspection of a large number of thought sequences (Shanon (1984b), (1989)) reveals that what is happening is akin to what happens when people actually act in the world – verbal discourse, social interaction, navigation in space, the handling and manipulation of objects. Indeed, on the basis of such observation I have suggested that this is precisely the function of consciousness – offer the ability to act in the world, be it physical or social, even when that world is not available or when concrete action in the world is too costly, risky or perhaps even frightening.

In sum, consciousness is a wonderful trick. It is a creation of a world within a world, as in the virtual theater<sup>2</sup> of the mind. This world within is not “real”, but psychologically speaking it has the same characteristics as the real world. Most significantly, it is a realm which is experienced in a concrete, as-if palpable fashion.

The perspective developed here also makes us appreciate why consciousness is so valuable. The reason is that it enables us to engage cognitively in the manner that our cognitive machinery is made to be – that is, in an embodied, situated fashion. Had cognition been defined by underlying representations and computational procedures consciousness would not be needed. Given that cognition is intrinsically linked to the body and the world, it is only natural that a mechanism has evolved for

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<sup>2</sup>The reader should be advised that my characterization of consciousness as a theater is not in the Cartesian sense discussed, and criticized, by Dennett (1991).

cognitive activity to proceed even when actual performance with the physical body in the physical world is restricted or even utterly unfeasible (for further discussion, see Shanon (1998), (2000)).

The last comments give further weight to our claim regarding the conceptual primacy of the body (and with it embodied, situated action in the world). The body is primary, and the two-tier approach totally wrong, because the basic mode of the human cognitive system (not of computer systems, about which I, being a psychologist, care nothing at all), is embodied being and acting in the world. Just as a television set or a computer is constructed under the assumption that a link to the electrical supply system is feasible, the human mind has been created assuming that from the very start, body and world will be available. Indeed, all throughout our lives we are in a body and in the world. As noted here, consciousness, which is perhaps the most human of all psychological phenomena, is also intrinsically grounded in the embodiment of cognition.

#### **POST-SCRIPT: THE MIND-BODY PROBLEM**

I started this paper advising that the body should not be equated with the brain. Here I would like to return to the consideration of both body and brain and relate them to one of the central issues in philosophy, namely, the *mind-body problem*.

Even the theoretically minded cognitive-psychologists may frown saying that the mind-body problem is a philosophical, even metaphysical, question and that as such it is outside the scope of cognitive-psychological discussion. Indeed, for a long time this was my stance too. Now I think differently. The disregard of the body by contemporary representational cognitive science reflects some fundamental conceptual perspectives that are rooted in older intellectual traditions. As discussed at length

in Shanon (1993a), modern RCVM is directly tied to Cartesian dualism which divides between the mental and the physical. Noting that in fact, several problems may be noted in the conjunction of mind and body, what I would like to do here is mark the relationships between these and the embodiment of cognition we have considered above.

Descartes's concern was the relationship between two types of ontological categories – that of the physical, which is primarily defined by spatial extension, and that of the mental, which lacks such extension. This *metaphysical* problem is very different from that which is of concern to modern students of mind. But it was Descartes himself who also introduced the modern *philosophical* question regarding the relationship between the mind and the body. In a fashion, the question is captured by a phenomenon such as my deciding to lift up my arm and the consequent lifting up of my arm. Mundane though it is, conceptually this phenomenon is a mysterious puzzle. In recent years this question has received a more *psychophysiological* flavor and nowadays it is usually interpreted as a mind-brain problem. In other words, it is the question of how mental events affect brain events and vice versa. Despite the spectacular developments in modern brain sciences, this question too remains an unsolved puzzle.

All these are questions that have been much discussed in the literature, and I will not say anything more about them here. Indeed, I do not think that modern cognitive psychology can add much to them. What I would like to point out is that there is another related question about which something can actually be said in the present context. I refer to this problem as the *self-body* problem. From the present perspective of psychology, which regards psychology as the science of experience, the question is not the relationship between an abstract entity called mind and the concrete entity called brain. Mind is a theoretically defined concept about which I, a cognitive agent, need not



know anything. Likewise, the brain is something that does exist in the world but which human beings have never seen (I am referring to each person's brain) and which they never have experience. As far as the phenomenology of experience is concerned, the real question does not pertain to the relationship between mind and brain. Rather, as attested by the case of lifting of my arm, phenomenologically, the puzzle has to do with the relationship between the subjective, experiential domain of concerns, wishes and decisions on the one hand and the physical domain of the body.

This brings us back to where we started. The topic of concern in cognition is the phenomenological body, not the brain. The brain is not given to me as a person, the phenomenological body is. The empirical study of mind, which by the perspective presented here is tantamount to the phenomenological study of experience, is concerned with the latter, not the former. Significantly, from the present perspective the gap between the two parameters constituting the pair by which the problem is defined seems to narrow. Unlike the extensional and the non-extensional, unlike the mental and the physical, self and body have something in common – both are experienced. Indeed, both pertain to me and both are sensed. The narrowing of the gap is, of course, in line with the narrowing of the difference between the internal and the external noted in the previous subsection of this paper.

By way of further clarifying the relationship between self and body I would like to introduce an analogy, that of a person playing a piano. The body for the self is, I suggest, like the piano for the pianist. The pianist cannot play without a piano. Of course, the piano is not all that is pertinent to music. There is also the specific score, whatever is to be said about the composer, the musical genre and style, and whatever pertains to the particular pianist's skill and mode of playing in general. The pianist could, of course, hum the music to himself/herself and not

an insignificant part of music education does not involve touching the piano at all (for instance, the pianist may listen to other pianists play, study harmony, reflect upon the music and so on and so forth). Yet, inasmuch as the pianist performs music, produces music – this cannot be done without the piano. Likewise with cognition. Whatever people do cognitively cannot be achieved without the body. Indeed, I would suggest that cognitive life be likened to a performance whose instrument is the body.

## REFERENCES

- ABELES, M. (1982). *Local Cortical Circuits: An Electrophysiological Study*. (Berlin, Springer-Verlag).
- AMIT, D.A. (1989). *Modeling Brain Function: The World of Attractor Neural Networks*. (Cambridge, Cambridge University Press).
- BATESON, G. (1972). *Steps Towards an Ecology of Mind*. (New York, Ballantine Books).
- BRADDELEY, A. D., ELDRIDGE, M., AND LEWIS, V. (1981). The role of subvocalisation in reading. *Quarterly Journal of Experimental Psychology*, **33A**, 439-454.
- CARTER, A.L. (1975). The Transformation of Sensorimotor Morphemes into Words: A Case Study of the Development of “More” and “Mine”. *Journal of Child Language*, **2**, 233-250.
- COHEN, B. H. (1986). The Motor Theory of Voluntary Thinking. In R.J. Davidson, G.E. Schwartz, and D. Shapiro (eds.), *Consciousness and Self-Regulation: Advances in Research and Theory*, Vol. 4 (pp. 19-54). (New York, Plenum Press).

- DASCAL, V. (1991). Walking the Tight Rope: The Psychotherapeutic Potential of Enacting a Movement Metaphor. *Assaph - Studies in the Theatre*, 7, 103-112.
- . (1992). Movement Metaphors: Linking Theory and Therapeutic Practice. In M. Stamenov (ed.), *Current Advances in Semantic Theory*. (Amsterdam, John Benjamins).
- DENNETT, D.C. (1991). *Consciousness Explained*. (Boston, Little, Brown and Company).
- DREYFUS, H.L. (1979). *What Computers Can't do: A Critique of Artificial Reason*, second revised edition. (New York, Harper and Row).
- . (1991). *Being-in-the-World*. (Cambridge, The MIT Press).
- DREYFUS, H.L., and DREYFUS, S.E. (with Athanasiou, T.). (1986). *Mind over Machine*. (New York, Free Press).
- FREEDMAN, N. (1989). Two Principles of Communicative Functioning. In R.R. Riber (ed.), *The Individual, Communication, and Society: Essays in Memory of Gregory Bateson* (pp. 279-300). (Cambridge, Cambridge University Press).
- FRYER, D.H. (1941). Articulation in Automatic Metal Work. *American Journal of Psychology*, 54, 504-517.
- GERGEN, K.J. (1985). The Social Constructionist Movement in Modern Psychology. *American Psychologist*, 210, 266-275.
- GIBSON, E.J. (1969). *Principles of Perceptual Learning and Development*. (New York, Appleton-Century-Crofts).
- . (1982). The Concept of Affordances in Development: The Renaissance of Functionalism. In W.A. Collins (ed.), *The Concept of Development*, (pp. 55-81). (Hillsdale, New Jersey, Lawrence Erlbaum).

- GIBSON, E.J., and SPELKE, E.S. (1983). The Development of Perception. In P. H. Mussen (ed.), *Handbook of Child Psychology*. Vol. 3: *Cognitive Development* (pp. 1-76). (New-York, John Wiley).
- GIBSON, J.J. (1966). *The Senses Considered as a Perceptual System*. (Boston, Houghton-Mifflin).
- . (1979). *The Ecological Approach to Visual Perception*. (Boston, Houghton-Mifflin).
- GUR, R.E., GUR, R.C., and HARRIS, L.J. (1975). Cerebral Activation, as Measured by Subjects Lateral Eye Movement, is Influenced by Experimenter Location. *Neuropsychologia*, **13**, 35-44.
- HALLE, M., and STEVENS, K.N. (1964). Speech Recognition: A Model and a Program for Research. In J.A. Fodor and J.J.Katz (eds.), *The Structure of Language* (pp. 604-612). (Engelwood-Cliffs, New Jersey, Prentice-Hall).
- HARDYCK, C.D., and PETRINOVICH, L.F. (1970). Subvocal Speech and Comprehension Level as Function of the Difficulty of Reading Material. *Journal of Verbal Learning and Verbal Behavior*, **9**, 647-652.
- HEIDEGGER, M. (1962). *Being and Time*. (New York, Harper and Row).
- HELD, R., and FREEDMAN, S.J. (1963). Plasticity in Human Sensorimotor Control. *Science*, **142**, 455-462.
- HELD, R., and HEIN, A. (1963). Movement-produced Stimulation in the Development of Visually Guided Behavior. *Journal of Comparative and Psychological Psychology*, **56**, 872-876.

- HENDRIKS-JANSEN, H. (1996). *Catching ourselves in the Act: Situated Activity, Interactive Emergence, Evolution, and Human Thought* (Cambridge, Mass., MIT Press).
- JACKENDOFF, R. (1976). Towards an Explanatory Semantic Representation. *Linguistic Inquiry*, **7**, 89-150.
- JAMES, W. (1912/1958) *Essays in Radical Empiricism: A Pluralistic Universe*. (Longmans, Green and Co.).
- JOHNSON-LAIRD, P.N. (1983). *Mental Models*. (Cambridge, Mass., Harvard University Press).
- JOHNSON, M. (1987). *The Body in the Mind: The Bodily Basis of Reason and Imagination*. (Chicago, Chicago University Press).
- . (1991). Knowing Through the Body. *Philosophical Psychology*, **4**, 3-20.
- KENDON, A. (1972). Some Relationships between Body Motion and Speech. In A. Siegman and B. Pope (eds.), *Studies in Dyadic Communication* (pp. 177-210). (New York, Pergamon Press).
- . (1975). Gesticulation, Speech and the Gesture Theory of Language Origins. *Sign Language Studies*, **9**, 349-373.
- . (1984). Some Uses of Gestures. In D. Tannen and M. Saville-Troike (eds.), *Perspectives on Silence* (pp. 215-234). (Norwood, New Jersey, Ablex).
- KOLERS, P.A. and ROEDIGER, H.L. (1984). Procedures of Mind. *Journal of Verbal Learning and Verbal Behavior*, **23**, 425-449.
- KOLERS, P.A. and SMYTHE, W.E. (1984). Symbol Manipulation: Alternatives to the Computational View of Mind. *Journal of Verbal Learning and Verbal Behavior*, **23**, 289-314.

- LAKOFF, G. (1987). *Women, Fire and Dangerous Things: What Categories Reveal about the Mind*. (Chicago, Chicago University Press).
- LAKOFF, G., and JOHNSON, M. (1980). *Metaphors We Live by*. (Chicago, Chicago University Press).
- LISHMAN, J.R., and LEE, D.N. (1973). The Autonomy of Visual Kinesthesia. *Perception*, **2**, 287-294.
- MCCLELLAND, J.L. and RUMELHART, D.E. (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*. Vol. **2**: Psychological and biological models. (Cambridge, Mass., MIT Press).
- MCGUIGAN, F.J., and RODIER, W.I. (1968). Effects of Auditory Stimulation on Covert Oral Behavior During Silent Reading. *Journal of Experimental Psychology*, **76**, 649-655.
- MCNEILL, D. (1975). So You Think Gestures are Nonverbal? *Psychological Review*, **92**, 350-371.
- MCNEILL, D., and LEVY, E. (1982). Conceptual Representations in Language Activity and Gesture. In R. Jarvella and W. Klein (eds.), *Speech, Place, and Action: Studies in Deixis and Related Topics* (pp 271-295). (Chichester, John Wiley and Sons).
- MERLEAU-PONTY, M. (1962). *The Phenomenology of Perception*. (London, Routledge and Kegan Paul).
- MURRAY, D. J. (1966). Vocalization-at-presentation and Immediate Recall, with Varying Recall Methods. *Quarterly Journal of Experimental Psychology*, **18**, 9-18.
- NEWELL, A. (1980). Physical Symbol Systems. *Cognitive Science*, **4**, 135-183.

- PAPERT, S. (1980). *Mindstorms: Children, Computers and Powerful Ideas*. (New York, Basic Books).
- PIAGET, J. (1954). *The Construction of Reality by the Child*. (New York, Basic Books).
- . (1970). Piaget's theory. In P. H. Mussen (ed.), *Carmichael's Manual of Child Psychology*, third edition (pp. 703-732). (New York, John Wiley).
- POLANYI, M. (1962). *Personal Knowledge*. (Chicago, Chicago University Press).
- . (1966). *The Tacit Dimension*. (Garden City, Anchor Books).
- PROUST, M. (1963). *Remembrance of Things Past*, Vol. 2. (New-York, Penguin Books).
- PUTNAM, H. (1973). Reductionism and the Nature of Psychology. *Cognition*, **8**, 263-368.
- . (1988). *Representation and Reality*. (Cambridge, MIT Press).
- RUMELHART, D. E. and MCCLELLAND, J. L. (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*. Vol. 1: Foundations. (Cambridge, Mass., MIT Press).
- RYLE, G. (1949). *The Concept of Mind*. (Cambridge, Hutchinson).
- SARTRE, J.P. (1957). *Being and Nothingness*. (London, Mathues).
- SCHANK, R.C. (1973). Identification of Conceptualizations Underlying Natural Language. In R.C. Schank and K.M. Colby (eds.), *Computer Models of Thought and Language* (pp. 187-247). (San Francisco, W.H. Freeman & Company).

- SEARLE, J.R. (1975). Indirect Speech Acts. In P. Cole and J.L. Morgan (eds.), *Syntax and Semantics 3: Speech Acts*. (New York, Academic Press).
- . (1979). Metaphor. In A. Ortony (ed.), *Metaphor and Thought* (pp. 92-123). (Cambridge, Cambridge University Press).
- SERAFINE, M.L. (1988). *Music as Cognition: The Development of Thought in Sound*. (New York, Columbia University Press).
- SHANON, B. (1984a) Meno. A Cognitive-Psychological Approach. *The British Journal for the Philosophy of Science*, **35**, 129-147.
- . (1984b). The Case for Introspection. *Cognition and Brain Theory*, **7**, 167-180.
- . (1989). Thought Sequences. *The European Journal of Cognitive Psychology*, **1**, 129-159.
- . (1990). Consciousness. *Journal of Mind and Behavior*, **11**, 137-152.
- . (1993a). *The Representational and the Presentational: An Essay on Cognition and the Study of Mind*. (London, Harvester-Wheatsheaf, 1993).
- . (1993b). Why Are We (Sometimes) Conscious of our Thoughts? *Pragmatics and Cognition*, **1**, pp. 25-50.
- . (1998). What is the Function of Consciousness? *Journal of Consciousness Studies*, **5**, 295-308.
- . (2001). Against the Spotlight Model of Consciousness. *New Ideas in Psychology*, **19**, 77-84.
- SUDNOW, D. (1980). *Talk's Body: A Meditation Between Two Keyboards*. (Harmondsworth, Penguin Books).



- THAGARD, P. (1986). Parallel Computation and the Mind-body Problem, *Cognitive Science*, **10**, 301-318.
- VARELA, F., THOMPSON, S., and ROSCH, E. (1991). *The Embodied Mind*. (Cambridge, MIT Press).
- VERA, H.A., and SIMON, H.A. (1993). Situated Action: A Symbolic Interpretation. *Cognitive Science* **17**, 1-48.
- VYGOTSKY, L.S. (1962). *Thought and Language*. (Cambridge, Mass., MIT Press).
- . (1981). The Genesis of Higher Mental Functions. In J.V. Wertsch, (ed.), *The Concept of Activity in Soviet Psychology* (pp. 144-185). (New York, Sharpe).
- WARREN W.H. (1984). Perceiving, Affordances: Visual Guidance of Stair Climbing. *Journal of Experimental Psychology: Human Perception and Performance*, **5**, 683-703.
- WARREN, W.H. and WHANG, S. (1987). Visual Guidance of Walking Through Apertures: Body-scaled Information for Affordances. *Journal of Experimental Psychology: Human Perception and Performance*, **13**, 371-383.
- WELLS, G.L., and PETTY, R. E. (1980). The Effects of Overt Head Movement on Persuasion; Compatibility and Incomparability of Responses. *Basic and Applied Social Psychology*, **1**, 219-230.
- WERNER, H., and KAPLAN, B. (1963). *Symbol Formation: An Organismic Developmental Approach to Language and the Expression of Thought*. (New York, Wiley).
- WINOGRAD, T. and FLORES, C.F. (1986). *Understanding Computers and Cognition: A New Foundation for Design*. (Norwood, New Jersey, Ablex).

ZAJONC, R.B., and MARCUS, H. (1983). Affect and Cognition: The Hard Interface. In C. E. Izard, G. Kagan and R. B. Zajonc (eds.), *Emotions, Cognition and Behavior* (pp. 73-102). (Cambridge, Cambridge University Press).