The Semiotic Function:
Studies in Children's Representations

by

Maare Tamm

Umeå 1990
The Semiotic Function:
Studies in Children's Representations

by

Maare Tamm

Doctoral dissertation to be publicity discussed in lecture room S2. at The Department of Psychology, University of Umeå, on March 30, 1989, at 13.15 p.m., for the degree of Doctor of Philosophy.

Umeå 1990

The main purpose of this thesis was to explore if there existed one single underlying semiotic function for representation. The problem was examined from both a theoretical and an empirical point of view.

In the first part of this thesis the theoretical considerations about Piaget's hypothesis of a single semiotic function are described and compared with a number of alternative approaches. The hypothesis is critically analyzed and its limitations are pointed out.

In the second part of this thesis the empirical studies are reported. One of the guiding lines for the experiments performed was the distinction made by Piaget between figurative and operative aspects of representation. The main conclusions to be drawn from the four studies were that they all supported, however tentatively, Piaget's hypothesis of a single underlying semiotic function. In terms of figurative and operative aspects of cognition it was concluded that the underlying form (the operative aspect) at different ages is constant across the different representation modes. The differences found in the figurative aspect of representation were bound to the representation media, and could vary as a function of media, task demands and individual differences.

In the third part of this thesis problems with representation media and task demands are discussed together with research in related areas of the semiotic function.

The general conclusions drawn from this thesis were that there might exist a single underlying semiotic function for representation. The issue is neither simple nor uncomplicated. The distinction made between the figurative and operative aspect of representation is considered as one attempt to narrow down the generality of the hypothesis, and to distinguish between what is expected to be a universal aspect of the semiotic function and what varies as a function of media, task demands and individual-, social-, and cultural differences.

Key words: Piaget, Semiotic function, Mental representation Figurative, Operative, Representation media.

Number of pages: 207
ISBN 91-7174-463-0
© Maare Tamm, 1989
The Semiotic Function:
Studies in Children's Representations

by

Maare Tamm

Umeå 1990
The main purpose of this thesis was to explore if there existed one single underlying semiotic function for representation. The problem was examined from both a theoretical and an empirical point of view.

In the first part of this thesis the theoretical considerations about Piaget's hypothesis of a single semiotic function are described and compared with a number of alternative approaches. The hypothesis is critically analyzed and its limitations are pointed out.

In the second part of this thesis the empirical studies are reported. One of the guiding lines for the experiments performed was the distinction made by Piaget between figurative and operative aspects of representation. The main conclusions to be drawn from the four studies were that they all supported, however tentatively, Piaget's hypothesis of a single underlying semiotic function. In terms of figurative and operative aspects of cognition it was concluded that the underlying form (the operative aspect) at different ages is constant across the different representation modes. The differences found in the figurative aspect of representation were bound to the representation media, and could vary as a function of media, task demands and individual differences.

In the third part of this thesis problems with representation media and task demands are discussed together with research in related areas of the semiotic function.

The general conclusions drawn from this thesis were that there might exist a single underlying semiotic function for representation. The issue is neither simple nor uncomplicated. The distinction made between the figurative and operative aspect of representation is considered as one attempt to narrow down the generality of the hypothesis, and to distinguish between what is expected to be a universal aspect of the semiotic function and what varies as a function of media, task demands and individual-, social-, and cultural differences.

Key words: Piaget, Semiotic function, Mental representation Figurative, Operative, Representation media.
Between the idea
And reality
Between the motion
And the act
Falls the shadow

T. S. Eliot

To Sandra
ACKNOWLEDGEMENTS

It has been a great privilege for me to participate for several years in the scholarly enterprise at the Department of Psychology at the University of Umeå.

I am deeply grateful to my first supervisor professor Berndt Brehmer, Department of Psychology, University of Uppsala, who brought me into and opened for me this fascinating area of research. During several years I have been privileged to enjoy his comprehensive knowledge of Piaget's theory and I am grateful for his professional guidance and continuous interest in my work.

I am especially indebted to my second supervisor professor Lars-Göran Nilsson, Department of Psychology, University of Umeå, for his extensive support and advice, his readiness to listen and discuss my work and his critical reading of this thesis. His professional guidance and personal encouragement has been of the greatest importance to me during the final part of my thesis.

My deep gratitude goes to my close friend and colleague professor Ingvar Lundberg for his never-ceasing interest in my endeavors in various fields, his encouragement and support, and his critical comments on the last draft of this thesis. During more than a decade I have enjoyed his friendship, and he has became an ideal to me in scholarship, writing and personal integrity.

My friend and colleague Dr. Jörgen Garvill has been a valuable source of support for many years. I thank him for innnumerous discussions regarding various issues related to different areas of research, for stimulating exchange of thoughts, and for his wise advice on my thesis.
I am deeply grateful to Dr. Lars-Åke Idahl, headmaster at the College for the Health Care Professions in Boden, for his encouraging interest in my work and for his moral support. I thank him also for his valuable help with the problems I had with my computer, and for his carefulness in checking my English.

Special word of thanks are due to all those who read and commented on the manuscript. Especially I thank Doctors Bo Molander, Tommy Gärling, and Erik Lindberg, Department of Psychology, University of Umeå, and professor Sten-Sture Bergström at Department of Applied Psychology in Umeå.

To all my friends and colleagues at the Department of Psychology, my thanks for good fellowship and intellectually stimulating exchange of ideas during many years.

Finally, I am deeply indebted to the staff at the Sociomedical Library in Boden, for their valuable work in providing the literature. They have handled their end of this project with skill, patience, and friendliness.

Umeå, February 1990
Maare Tamm
<table>
<thead>
<tr>
<th>CONTENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>THE SEMIOTIC FUNCTION: THEORETICAL FOUNDATIONS</strong></td>
<td>16</td>
</tr>
<tr>
<td>Figurative and operative knowledge</td>
<td>25</td>
</tr>
<tr>
<td><strong>ALTERNATIVE PERSPECTIVES</strong></td>
<td>28</td>
</tr>
<tr>
<td>The cognitive-structural approach</td>
<td>28</td>
</tr>
<tr>
<td>The empiricist approach</td>
<td>40</td>
</tr>
<tr>
<td>The nativist point of view</td>
<td>43</td>
</tr>
<tr>
<td>The artistic approach</td>
<td>45</td>
</tr>
<tr>
<td><strong>METHODOLOGICAL CONSIDERATIONS</strong></td>
<td>50</td>
</tr>
<tr>
<td><strong>EXPERIMENTAL STUDIES</strong></td>
<td></td>
</tr>
<tr>
<td>Study 1. Relations between drawings and play-constructions in four and six-year-old children</td>
<td>57</td>
</tr>
<tr>
<td>Study 2. Rules used by four- and six-year-old children to generate representations in drawing and play construction</td>
<td>85</td>
</tr>
<tr>
<td>Study 3. Relations between imitation and drawing in four- and six-year-old children</td>
<td>105</td>
</tr>
<tr>
<td>Study 4. Relations between verbal and pictorial information in representation in four-, six, and eight-year-old children</td>
<td>125</td>
</tr>
<tr>
<td><strong>DISCUSSION</strong></td>
<td>149</td>
</tr>
<tr>
<td>Summary and discussion of theoretical assumptions and earlier findings</td>
<td>150</td>
</tr>
<tr>
<td>Problems with representation media and task demands</td>
<td>167</td>
</tr>
<tr>
<td>Research in related areas of the semiotic function</td>
<td>176</td>
</tr>
<tr>
<td>General conclusions and suggestions for future research</td>
<td>186</td>
</tr>
<tr>
<td><strong>REFERENCES</strong></td>
<td>191</td>
</tr>
</tbody>
</table>
INTRODUCTION

The world of human beings is made up of a web of symbols. Actual perceptions come and go, and are to some extent beyond our control, but symbols may be discovered or produced by will, and manipulated with great freedom. The demarcation line between animals and men, is often considered to be at the level of symbols.

Already in the very beginning of childhood (at the emergence of pre operational development stage) the child constructs "inner symbols" of external objects. In so doing, he or she no longer lives in a sensible world that is simply given and present, but in a world perceptible only through a variety of symbols. At the center of human experience, then, there is always the need to symbolize reality, through words, images, pictures, gestures or other symbols.

From a philosophical perspective a human being might be thought of as animal symbolicus. Cassirer (1944) described the peculiar world of this symbolic animal as follows:

Physical reality seems to recede in proportion as man's symbolic activity advances. Instead of dealing with the things themselves, man is, in a sense, constantly conversing with himself. He has so enveloped himself in linguistic forms, in artistic images, and mythical symbols or religious rights, that he cannot see or know anything except by the interposition of this artificial medium. He lives in the midst of imaginary emotions, in hopes and fears, in illusions and disillusions, in his fantasies and dreams. (p. 25)

From a psychological perspective, exemplified by such researchers as Bruner, Olver and Greenfield (1966), Piaget (1951), Vygotsky (1962), and Werner and Kaplan (1963),
scientists consider symbolic activity as pre-eminently an intellectual achievement.

For Werner and Kaplan (1963) the symbol is the instrumentality through which man conquers the world's confusion and chaos and his own disorientation, through knowing. Piaget (1951) considers the symbol as the unit of representational intelligence and basic to all further intellectual development. The activities of many preschool children, such as play, drawing, linguistic imagination and gestural imitation, are, according to Piaget, manifestations of the child's conceptual immaturity, and could be considered as expressions of a cognitive imbalance typical of an early stage of human development. Thus, cognitivists focus on the intellectual underpinnings supporting competent symbol use, and they concern themselves with the use of symbols mainly as evidence for mental growth.

The psychoanalytic approach, exemplified by Erikson (1950), Freud (1961a,b), Klein (1932), Mahler, Pine and Bergmann (1975), and Winnicott (1971) is centering on affective aspects of symbol use. As stated by Klein:

The child expresses its fantasies, its wishes, and its natural experiences in a symbolic way through play, and games. In doing so, it makes use of the same archaic and phylogenetic mode of expression, the same language, as it were, that we are familiar with in dreams; and we can only fully understand this language if we approach it in the same way Freud has taught us to approach the language of dreams. (p. 29)

In spite of many differences among the three approaches mentioned above there are some important similarities. All three approaches claim that the reality of man is created by symbols, that the symbols are the functioning of thought itself, and that it proves impossible to think of symbolic activity apart from human imagination and creativity. In other words: man lives in a symbolic universe.
In 1969, Jean Piaget wrote, together with his associate Bärbel Inhelder, a book entitled *The psychology of the child*. In one of the chapters of this book he outlined his hypothesis of a common underlying semiotic (or symbolic) function for representation. The semiotic function, presents, according to Piaget, a remarkable unity, in spite of the astonishing diversity of its manifestations. It is in Piaget's opinion, the basis of all symbolic or representative activity in child and in man on the whole.

To come to grips with the world of symbols is (according to both Piaget and many others) the principal challenge of the years following infancy. The progress in symbol use occurs on many fronts. Children learn to draw pictures, to tell stories, to play with toys, to sing, to dance and to use gestures. They discover that they can use language both to get things done in the external world and to manipulate the inner world. The preoperational development stage, from age two to seven, is a time during which the child's capacity to use, manipulate, transform, and comprehend various symbols matures at a rapid pace.

What is most striking about the events of this period is that they seem to be similar in most children and that specific instructions has relatively little effect on what the child does. Of course there are individual differences between the children. Some favour one symbolic mode more than the other, e.g., some are more advanced in story telling than in drawing, others prefer singing or dancing to symbolic play. Yet, over and above these differences, the principal stages affecting young children across symbolic modes, are persuasively similar. As Gardner (1982b) puts it:

> My best guess is that during this symbolic period the child is propelled by a dynamism that is largely his own. Like the seed with its own plan for development, the child is following the inner logic dictated by his own sensimotor development
and the nature of the particular symbols with which he is working. While children will naturally (and properly) draw what they see around them and tell stories about beguiling objects in their environments, external interference and efforts at explicit instruction rarely prove valuable or productive. (p. 212)

Even though an insistence on the importance of the development of symbol use is agreed upon among researchers, little has yet been done concerning the early course of this crucial human ability in relation to the semiotic function. There are many important issues to investigate, and many questions to ask. On of these is: Is the course of symbolization similar across the different representation modes, indicating the existence of one common underlying semiotic function, or are there instructive differences characterizing the manner in which children achieve symbolic competence in different media?

The purpose of this thesis was to explore this question. In so doing, a number of experiments were designed, each of which studied different relations between separate forms of the semiotic function. In the first study the preoperational child's drawing and play-constructions were investigated. In the second study the focus was on the child's drawing and gestural imitation. The third study compared verbal and pictorial representation in both preschool and school children.

It should be emphasized that when I began this line of research several years ago, I had no coherent overview of my goals and the proper methods to achieve them. By bits and pieces, as I tried to make sense of what I was doing and to plan how next to proceed, I began to develop a set of principles for guiding my inquiry, which led to a more explicit theoretical awareness.

In the first part of this thesis I shall describe the theoretical considerations about Piaget's theory of a
single semiotic function. Piaget's approach has been criticized from a variety of perspectives. I will proceed by examining a number of these, point to the limitations of Piaget's approach, and discuss some of the methodological difficulties when investigating the issue.

In the second part the empirical studies are reported. In the context of these, earlier research from the different areas - symbolic play, drawing, gestural imitation, verbal and pictorial representation - is reviewed.

The study will conclude with a discussion of the main results and with a general discussion concerning, among other things, the development of the symbolic function, the power of symbols to carry meanings within a given culture, and the role of representation media involved in symbol use. This section is the third and final part of the thesis.
Piaget's theoretical perspective is unusual because it goes well beyond what is commonly considered to fall within the legitimate sphere of psychological science. Piaget preferred to term himself a genetic epistemologist - one who studies the origins of human knowledge. Research work in genetic epistemology seeks, as a rule, to analyze the mechanisms of the growth of knowledge. Piaget began in the early 1920s to make interviews with children, he listened carefully to their responses, he focused on the strategies they used and the errors they made, and he arrived at the conclusion that children at different ages construct the world in ways that are fundamentally different from those of adults. His method was continuously alternating between observational exploration and hypothesis testing.

One of the ingenious insights of Piaget (Piaget & Inhelder, 1969) is to have discovered the unifying symbolic character of such different activities as drawing, symbolic play, imitation, language and mental imagery. Piaget attributes these behaviors to the semiotic function. This function, that appears at the beginning of the preoperational development stage, gives rise to representation as "symbolic", and consists in the ability to represent things by means of symbols (signifiers).

Piaget distinguished at least five manifestations of the semiotic function, whose appearance is almost simultaneous, and which could be listed in order of increasing complexity as follows:

Deferred imitation
As imitative movements become separated from the context of the perceived original, Piaget (Piaget & Inhelder, 1969)
considers such deferred imitation to be the first manifestation of symbols, and the beginning of representation. This occurs at the end of the sensori-motor development stage. The child who reenacts a scene from, say, yesterday represents through symbol formation the event which was yesterday present to him through object formation. Action is now liberated from the sensori-motoric requirements of direct perceptual copy and reaches a level where the actions are detached from their context, and become representational.

The ability to represent widens the knowing life of the child to an unprecedented degree. It gives food to his growing symbolic thinking and functioning, which otherwise would be limited to perceptual events of here and now.

**Symbolic play**

Symbolic play (or the game of pretending) is the second basic form of the semiotic function. In symbolic play the child uses external things and imitative gestures as symbolic representations. Symbolic play serves an important function: it enables the child to escape, at least momentarily, from some of the demands of the adult world. The child accomplishes this via the distortion of reality in symbolic play, which take the form of wishfulfillment, reconstruction of past events, compensation for undesirable outcomes, and liquidation of conflict.

Piaget perceives symbolic play as subordinating reality to the whims of the ego. This means, that the child assimilates reality to his needs and desires, instead of accommodating the ego to reality. Imitation, on the other hand (when it constitutes an end in itself) is, according to Piaget, accommodation to external models.

Symbolic play enables the child to maintain a sense of continuity and to establish a measure of ego balance. This balance, which rests on affective factors, is of
considerable importance, since the cognitive operations for the establishment of a genuine equilibrium have not yet been constructed. Not until the next stage, the concrete operational stage, there is an equilibrium between assimilation and accommodation, which results, according to Piaget, in intelligent behavior. This means that the child's representations will be adequate to the information given.

Since the child's purpose in symbolic play is to assimilate things to his self without accommodating to their "real" character, Piaget sees in play a preponderance of assimilative activity over accommodation. However, this assimilation to the self is not blind. The doll-playing child who substitutes one object with another, is aware of the difference between the real object and the substitute, and can because of this double knowledge use one symbol for the other. The assimilation to own wishes is, thus, functional.

**Drawing**

Drawing is the third form of the semiotic function. It should be considered as being halfway between symbolic play and mental image (the next manifestation of the semiotic function). It is like symbolic play in its functional pleasure, and like the mental image in its effort at imitating the real.

Drawing in its initial forms is closer to assimilation than to accommodation. The child's early scribbling usually has an undirected intent. When a young child draws a pattern of lines and then names it "rain", it can be assumed that the form was produced without the intent to picture rain, that the action involved in the drawing was action per se, and that the meaning was discovered in the act of making, or added to the drawn pattern afterwards. The child's drawn symbols are, thus, still highly personal, and the realism in drawing is, in terms of Luquet (1927), "fortuitous".
Some years later, at about five years of age, the child can draw quite realistic representations of the objects and events around them, but he cannot yet coordinate properly the various elements of his graphic products, and may instead simply juxtapose these elements beside one another in the drawing. The graphic symbols in the child's drawing reflect, according to Piaget, the child's mental immaturity, indicating that assimilation and accommodation are still in disequilibrium.

Not until the age of nine or ten, in the middle of the concrete operational stage, the child is able to coordinate the drawn elements into a coherent whole taking into account the principles of visual perspective, thus drawing background objects smaller than foreground objects, and eliminating from his drawing those objects which are invisible from his point of view.

Piaget (1951) points out that young children's drawings are always realistic in intent, consisting essentially of an attempt by the child to imitate, within the graphic medium, the properties of the objects being drawn. Piaget therefore views drawing as an activity which is characterized by imitative accommodation, where the child always adjusts his own graphic symbols in order to make them represent and imitate reality. Consequently, Piaget considers drawing to be much more closely related to the construction of mental images (which also imitate reality) rather than to the symbolic play of the child.

Mental images
The fourth form of the semiotic function consists of mental images. Mental images are, according to Piaget (Piaget & Inhelder, 1969, 1971), internalized forms of imitations. The internalization is to be understood in a literal manner. The external body movements that overtly imitate the shape of an object, are similar in nature to the covert
muscle movements that we may experience when invoking the image of the same object. Deferred imitations that are internalized and reduced in their overt activity are for Piaget what we commonly experience as images.

In the same way as the adult, the child needs a system of symbols (signifiers) dealing with objects, events, and with his or her whole past experience. This role has been assigned by Piaget to the image, which has to be considered as a symbol. Images are, thus, one basic form of symbols, functionally certainly the most important ones, without which a normal development of intelligence would be impossible.

Piaget distinguished between two broad categories of mental images: reproductive images, which include realities and perceptions perceived previously, and anticipatory images, which envisage movements of transformations as well as their results, although the individual has not previously observed them.

Mental images of the child at the preoperatory level are, according to Piaget, exclusively static. Children cannot yet anticipate transformations. Given two parallel lines which are shown to be of equal length, a child observes how one line is moved slightly to the right. He will now assert that that line has become longer. Similarly, drawings that copy or anticipate movement are wrongly executed. At best children show the correct initial and final state, but are quite incapable of forming images of the in-between states.

According to Piaget, mental images constitute a system of symbols, and not just faint copies or traces of things seen. They are partly derived from what the child understands or misunderstands, i.e. they provide a more or less accurate but delayed translation of the child's preoperatory level of comprehension. In terms of assimilation and accommodation, the mental image, at this
stage of development, is closer to accommodation than assimilation, thus trying to copy reality. However, it is worth emphasizing that according to Piaget an image cannot be considered in isolation. Because of its symbolic and significative character an image is linked to the whole cognitive activity of the thinking person, and accordingly, at this level, to the semiotic function.

Language

Language is the fifth manifestation of the semiotic function. It differs from the preceding forms of symbolic activities in that its specific form is, according to Piaget, not invented by the child, even if it certainly has a hereditary base. Rather it is discovered by the child and gradually learned through a constant interaction with the people around him. Language constitutes a relatively autonomous system of symbols, which the child has to learn in a radically different way, compared to the other manifestations of the semiotic function.

The transition from mere emotional expression in sounds and early "holophrases" to language proper, appears at the beginning of preoperational stage. It marks a very important change in the child's orientation to the world around him. At the age of about two years, in most children there is an intense interest in the names of things, which remains strong for several years. The things around the child take on new meaning when he learns their names, and experiences become something different when he can pin them down with words.

By naming the environment with words, that are common property of all people in a particular language group, the child is building up a symbolic world. This world is characterized by a freedom from immediacy. Since it is dressed in language, it is a world that one can share with others.
According to Piaget (Piaget & Inhelder, 1969), language then increases the powers of thought in range and speed. Whereas sensori-motor action patterns are obliged to follow events in time, verbal patterns can represent a long chain of actions very rapidly. Whereas sensori-motor adaptations are limited to space and time, language liberates thought from the immediately given, and enables it to range over time and space. These advantages of representative thought over sensori-motor actions are, as Piaget views it, due to the semiotic function. The semiotic function, then, detaches thought from action, and language plays an important role in this formative process.

At the preoperational developmental stage the child's thought and language are, according to Piaget (1928), characterized by egocentrism. This means, among other things, that the child cannot yet distinguish between the words of the language and the reality that these words signify. Words are, for the child at this age, a part of material reality, i.e. rather than being treated as symbols for objects they are treated as a properties of the objects.

Gradually the child becomes aware of the words separate existence. The names now become dissociated from things. They are first shared with the people who are well-known to the child, and finally, at the age of ten or eleven, they are considered as conventional signs shared by others.

As a further illustration of language use in preoperative children, Piaget (1928) points out the significance of the egocentric speech. In egocentric speech, which characterizes this developmental stage, the child talks mainly about himself. He takes little interest in his interlocutor, does not make special efforts to communicate ideas, expects rarely answers, and often does not seem to care whether anyone listens to him. The language use is similar to a monologue in play: The child is thinking
aloud, keeping up a running accompaniment, as it were, to whatever he may be doing. Thus, the child uses language as a symbolic instrument for representing to himself things which he knows.

According to Piaget, the egocentric speech of children reflects their thought. This means, that it is the language that is in the service of thought, and is structured by it. For Piaget, verbal language as such does not have a privileged place with respect to the development of representational thinking. Instead, he views language behavior within the same context as other forms of symbolic behavior. Piaget himself puts it like this:

If it is legitimate to consider language as playing a central role in the formation of thought, it is so far as it constitutes one of the manifestations of the symbolic function while the development of this symbolic function is itself dominated by the intelligence in all its aspects. (Piaget, 1963, p. 57, cit. by Furth, 1967, p.824.)

In whatever way the acquisition of language is explained, Piaget's hypothesis of a common semiotic function reminds us that any specific symbolic behavior, including language behavior, is inherently dependent on the child's knowledge of the world and on the semiotic function in general. In this perspective language acquisition is not unlike image formation. As Furth (1969) points out:

"The main difference between these two processes is that language imitates a 'symbolic event', image a 'real' event." (p. 114)

Concluding remarks
According to Piaget the genesis of the mechanism of knowledge is to be found in the constructive activity of the subject. At the preoperational stage of development the constructive process is performed by means of symbols. From now on the growing knowledge of the physical world constantly interacts with the child's own and other people's symbolic behavior. This manyfold symbolic
behavior, is, according to Piaget, governed by a single underlying function.

Thus, in Piaget's view, the ability to represent knowledge to oneself and others is a constructive process that presupposes a lengthy series of actions upon the environment. Mental representation by means of symbols, makes possible deferred imitation, symbolic play, drawing, mental images, language - in fact the whole range of symbolic capacities. Piaget groups together this family of representations, and refers to it as the semiotic (or symbolic) function. This function emerges, according to Piaget, at a certain point of development, and extends itself over the whole preoperational stage, into the mature thinking.
Figurative and operative knowledge

After our first empirical study we became aware of the usefulness and the importance of the distinction made by Piaget between figurative and operative knowledge. This distinction became one of the guiding lines for our empirical studies and for our reasoning through the whole thesis.

According to Piaget (Piaget & Inhelder, 1973) the figurative aspect of thought is static and refers to the product of the semiotic function, i.e. to the material content upon which the operations work. These static configurations are relatively easy to translate into images, and they do not by themselves change the stimulus in question.

The operative aspect of thought, by contrast, is characterized by its ability to transform one reality state into another. Operative knowledge, thus, changes the stimulus situation through the individual actions on it and through his reflections upon these actions.

For Piaget, operative knowledge is a function of the development stage of the child and therefore indirectly of age. It is the code or rule system through which the child transforms a given situation into something that he understands. It does not have any concrete (figurative) content, rather it acts on things and transforms them.

Operative knowledge is linked with the development of thought, from birth to adulthood. Accordingly, it shows the structurally distinct developmental stages. This means, that at each developmental stage the child's
representations are constructed by rules which characterize the developmental stage in question.

For Piaget both figurative and operative mode of cognition constitute a necessary skill in the individual's symbolic functioning. Although, both aspects are parts of the global behavior of intelligent thinking, Piaget regards the operative aspect as the essential aspect of prelogical and logical knowledge.

In studying the development of semiotic function it is, in our opinion, important to investigate both the figurative and the operative aspects of representation. This was done in our empirical studies. In Study I the figurative aspects of representation were investigated, i.e. the descriptive or figurative end product of the child's construction process. If we had been content with investigating only this aspect of representation we had missed a relevant point in the representation process, namely the rules used by the child in constructing representations. In Study II and Study IV, therefore, the operative aspects of representation were investigated, i.e. the transformation rules used by the child. In Study III the figurative aspects were investigated, thereby paralleling the Study I.

Although Piaget stressed the interaction between the figurative and operative aspects of knowledge, and although both aspects of knowing are, according to him, required for representation, he never outlined a theory of how these two aspects of knowledge are related to each other in the semiotic function. In the absence of theoretical interpretation, and in the absence of empirical evidence we have to make a number of hypothetical statements:

We argue, therefore, that if both the figurative and the operative aspects of symbolic representation develop in a similar manner in the different manifestations of the semiotic function, then it would provide a relatively
strong support to Piaget's idea of a common semiotic function.

It is further argued, in line with Piaget, that the operative aspect of knowledge is more instructive than the figurative aspect. Thus, when the child constructs his representations by means of representation rules, the strategies he uses and the errors he makes give us more information than the end products of representation. If the end products are dissimilar in the different representation modes, this could be due to the representation media in which the child has to construct his representation, rather than to the absence of a common semiotic function. (The media in the present context are such as drawing, play-construction, gestural imitation etc.)

Finally, if neither the figurative nor the operative aspects of representation are similar in the different representation modes, then Piaget's hypothesis of a single underlying semiotic function has to be rejected.

Since misunderstandings concerning Piaget's theory frequently center around the notion of representation (cf. Furth, 1969) it has to be pointed out, that Piaget used the term "representation" in two different senses.

For Piaget, representation in a wide sense (see Piaget, 1951, p. 68), a sense also used in the present context, is identical with thought, and at the preoperational level with symbolic thought. This, in turn, includes both an operative and a figurative aspect.

In the narrow sense, Piaget limited representation to the mental image or to the memory-image, that is, to the symbolic evocation of absent realities (Piaget, 1951, p. 68).
ALTERNATIVE PERSPECTIVES

To be great is to be misunderstood.

Ralph Waldo Emerson

There are many scholars who call in question Piaget's hypothesis of one single semiotic function. Many scholars have also offered alternative explanations to symbolic activities. One the following pages we shall analyse some of the alternative views. These can be summarized under following headings:

1. The cognitive-structural approach to representation
2. The empiricist approach
3. The nativist approach
4. The artistic approach

1. The cognitive-structural approach

Within the cognitive-structural approach dealing with symbolic functioning, representation, language etc, two scholars in particular should be mentioned in the present context - Jerome Bruner and Lev Semenovich Vygotsky.

Bruner's three modes of representation

In his book Studies in cognitive growth, dedicated to his friend and mentor Jean Piaget, Bruner (Bruner et al., 1966) views the child as developing through three more or less distinct developmental stages - the enactive, ikonic and symbolic - each characterized by its typical mode of internal representation. As Bruner himself describes them (Bruner et al., 1966):
At first the child's world is known to him principally by the habitual actions he uses for coping with it. In time there is added a technique of representation through imagery that is relatively free of action. Gradually there is added a new and powerful method of translating action and image into language, providing still a third system of representation. Each of the three modes of representation - enactive, ikonic, and symbolic - has its unique way of representing events. (p. 1)

To begin with, Bruner holds that these three representational systems should be viewed as three distinct stages of development. The first stage - the enactive - begins in the early days of life when the infant's action is related to "seeing". At this stage action and external experience are fused. However, Bruner says in contrast to Piaget, that we know very little about the way in which action fuses with percept and how the separation of the two spheres comes about later on.

A second stage in representation emerges, according to Bruner, when a child is able to represent the world to himself by an image that is relatively independent of action. At the end of the first year the child is on his way towards this accomplishment. At the outset there remains, however, a strong dependency on enactive representation as a necessary aid to imagery. When imagery (the ikonic representation) becomes the preferred mode of representation, it is no longer directly linked to action. Furthermore, Bruner argues that by the time ikonic representation is established there is a separation between the child's inner world and the world around him. In Bruner's (Bruner et al., 1966) own words:

There will often be some confusion even in the three-year-old between what is internal to his own experience and what is "external" in the sense of its being shared by others (as with respect to his dreams), but the separation by now is a relatively clear one (p. 29).
For Piaget, by contrast, the egocentric thinking of the preoperative child is characterized just by the child's confusion of the "inner" world with the external reality.

At the third developmental stage the symbolic representational system develops. It stems, according to Bruner, from a primitive and innate system that is species-specific to man. This system becomes through acculturation gradually specialized, and results in its most specialized form into language. What is striking about language is that in one of its aspects, the syntactic sphere, it reaches maturity very swiftly. This specific kind of maturity seems, however, unconnected with other spheres. For example, the child who can master words and sentences cannot in a corresponding fashion organize the things that the words and sentences "stand for".

For Bruner, in order to use language as an instrument of thought, the child must first bring the world of experience under the control of his thought processes. Not until language is applied to experience and thought, it is possible for the child to use language as an instrument of thought. Until this time language and experience maintain, according to Bruner, an important independence from each other. This view of Bruner is in disagreement with Piaget's view of language.

The interaction of representational systems
According to Bruner (Bruner et al., 1966) there are three basic ways in which two representational systems can relate to each other: by matching, by mismatching, or by independence of each other.

As mentioned before the syntax of language is mastered by the young child before he seems able to use it to organize his experience or his actions. This is, according to Bruner (Bruner et al., 1966) an example of independence of the two systems. However, "...as soon as there develops an
organization of experience that is in some sense capable of "matching" the properties inherent in language, the state of independence between the two systems recedes". (p. 49)
The two systems relate now to each other by matching.

The third way, mismatching, refers to a conflict between two representational systems. For example, when a child is shown that a particular magnitude (a ball of clay) has changed its appearance (is flattened out), it is still the same magnitude. There is, thus, mismatching between the "appearance" and the "reality". "Appearance" is defined by ikonic representation, "reality" by symbolic.

According to Bruner the conflict between different representation systems promotes growth. However, these systems can also work quite independently of each other, still promoting growth. For example, before the school start, and in societies where there is no institutional pressure, the enactive, ikonic and symbolic modes can function separately. In our society, on the other hand, where the formal education puts pressure to the individual to use symbolic representation, the three systems can be integrated partially (Bruner, et al., 1966; Mosenthal, 1975; Olson & Bruner, 1976).

Unlike Piaget, Bruner then does view representation as three different (sometimes interacting) modes of knowing, and not as being descended from a single underlying symbolic function.

Another distinction worth making between Bruner and Piaget is that Bruner views representation as an ability structured by culture, while Piaget considers symbolic representation as a universal intellectual ability.

According to Bruner, our Western way to represent reality is heavily culture-bound. As a fact, development itself is, according to Bruner, culture-bound (Bruner et al., 1966;
Olson & Bruner, 1976). To develop the point: When a person constructs representations, he or she does so by relating information to a previously acquired frame of reference. This frame of reference, shaped by cultural factors, gives meaning and organization to the individual's world. Thus, the culture in which the individual lives structures the individual's symbolic representation of reality.

In our Western culture, with its technical orientation, much of the learning occurs outside the context in which it will be used. Under these circumstances the symbolic representation is favoured at the expense of the ikonic and enactive modes of representation. Language enters as a means of conveying the content of experience and of action, and helps to develop correspondence between the three modes of representation.

In other, traditional (i.e. nontechnical) cultures, where learning is imbedded in the context of action, the enactive and the ikonic modes of representation are, according to Bruner, the main modes by which the individual is coping with the demands of his or her society. Cognitive tasks that can be carried out only by symbolic (i.e. verbal) means, turn out to be virtually impossible in these kinds of cultures.

In Bruner (Bruner et al., 1966) terms, then, the representation of reality "develops as a function of the uses to which it has been put first by the culture and then by any of its members who must bend knowledge to their own uses" (p. 320). According to Bruner, representation models are first adopted from the culture and then adapted to individual use. That means, the language, the values, and the ways of perceiving, experiencing and thinking, as expressed in an individual's life, reflect his mode of coping with cultural reality.
Piaget's reluctance to deal with social and cultural facts of cognition is, beside Bruner, also pointed out by several others (Cole et al., 1971; Lévi-Strauss, 1962; Luria, 1976; Olson, 1970; Vygotsky, 1978). As a matter of fact, this point has for a long time been a major demarcation line in developmental psychology, between those who are proposing for the existence of invariant general cognitive structures and processes, and those who are arguing for alternative development pathways due to different social, cultural and historical backgrounds.

Vygotsky's view of cognition
Lev Vygotsky (1962, 1976, 1978), a psychologist from the Russian school disagreed with Piaget on several issues. First, Vygotsky had a separate view about the relationship between thought and language, second, he proposed a cognitive account of play which differed from that of Piaget, and third, he had an alternative explanation to give to the development of scientific concepts in childhood (De Lisi, 1982; Gardner, 1982a; Isenberg & Jacob, 1983; Segal, 1982; Wertsch, 1979). The two first points are of interest for the present case, the third, considering school-age children, is outside the present scope.

Thought and language
On the development of thought and language, Vygotsky (1962) maintained that although in the adult life thought and language are closely connected, the connection is not primary in that it does not always exist. In Vygotsky's view, the roots and the developmental course of the thought differ from those of speech. Vygotsky viewed language and thought as developing independently until the stage of naming at about two years of age. Prior to this, there is, according to Vygotsky, a "preverbal stage" in the development of thought and a "preintellectual stage" in speech development. That is, there are forms of thought
that are unconnected to speech. Thought and speech have, for Vygotsky, thus, independent origins.

In infancy and early childhood, the early forms of thought and speech are manifested and perfected on a social plane, i.e. in parent-child interactions. Unlike Piaget, Vygotsky argued that the early forms of children's speech are social in that they serve a communicative function. As for the early forms of thought, Vygotsky considered that parents often serve as monitors as they assist and direct their children's behaviors. Language, then, is the primary mechanism used by adults to monitor a child's behavior.

As a consequence of social experiences with parents, language and thought are gradually integrated into one psychological function, rather than remaining separate. That is, children begin to use language in the service of thought.

Vygotsky (1962) identified three stages in this process of the merging of language and thought. These are: external speech, egocentric speech, inner speech.

At first, speech merely follows a child's purposeful actions (external speech). Next, speech accompanies a child's actions and helps the child in the solution of internal problems. This is comparable to the egocentric speech that Piaget described. However, unlike Piaget, Vygotsky stresses the link between the egocentric speech and the planning function, which helps the egocentric speech turn into thought proper. In the final stage, speech precedes actions and serves to organize them ahead of time. At this point, the speech that accompanies external operations turns inward and becomes inner speech. When egocentric speech becomes internalized as inner speech, the shift from the interpersonal to the intrapersonal plane of function is, according to Vygotsky, completed.
The role of egocentric speech is, thus, for Vygotsky, to become inner speech. Inner speech differs from social speech in both function and structure. Whereas the function of social speech is communication, inner speech serves as the individual's own tool for thought. As far as the structure is concerned inner speech is abbreviated and telegraphic in comparison to social speech.

Nevertheless, Vygotsky did not equate thought with inner speech. The two functions have, according to him, independent origins and remain distinct. Even after being merged, thought and speech were likened to two overlapping circles. In their overlapping parts, thought and speech coincide to produce what is called verbal thought and rational speech.

According to Vygotsky, verbal thought does not by any means include all forms of thought, and rational speech does not include all forms of speech. Rather there is a vast area or thought that has no direct relation to speech. On the other hand, there is a form of speech where no thought processes may be involved. For example, when an individual silently recites to himself a poem learned by heart, or when he or she uses "lyrical" speech prompted by emotion.

Obviously Piaget's and Vygotsky's views differed on several points. Piaget argued that the structure of thought determines the use and understanding of language. Vygotsky, on the other hand, meant that there exists a dynamic and changing relationship between language and thought, from relative independence in early childhood to fusion and integration in adulthood.

Another point where Vygotsky disagreed with Piaget has to do with egocentric speech. According to Vygotsky, Piaget had interpreted egocentric speech too exclusively as reflecting an egocentric orientation of the child's
thought. Moreover, Piaget had payed too little attention to the social character of the child's "egocentric" language.

In Vygotsky's view egocentric speech represents an important and necessary stage in the child's development. It is a transitional stage in the evolution from vocal to inner speech. By talking aloud, children are thinking for themselves - conceptualizing problems and solving them. When the child grows older egocentric speech becomes inner speech, which, according to Vygotsky, is a form of silent thinking in terms of language. Vygotsky, thus, disagrees with Piaget who meant that egocentric speech simply fades away as the child grows older (cf De Lisi, 1982).

With regard to the social value of egocentric speech Piaget said, by contrast to Vygotsky, very little about child-adult relations, e.g. children's use of language in the company of their parents and teachers. Furthermore, Piaget ignored to observe when children's use of speech in the company of their peers was social rather than egocentric. By focusing on egocentrism Piaget may have underestimated children's social aspects of language.

With regard to the social value of egocentric speech, Piaget himself admitted, in response to Vygotsky, that he had failed to take into account the social aspects of egocentric speech (see Piaget, 1962). He agreed with Vygotsky that children talk more when there are other children present, however, the speech of the child is, according to Piaget, even in these cases still egocentric. This means that the speech of the child refers to the planning and evaluating of his or hers own activity rather than to communicate ideas to others. Nevertheless, Piaget admits, that the awareness of the other child's presence stimulates both the child's cognition and his or her speech activity.
Differences between the social-political context in which Piaget and Vygotsky worked probably contributed to their different approaches. Vygotsky's socialist position is exemplified in his argument that language has, as its primary purpose, a social function. Piaget, on the other hand, emphasized the biological aspects of development. However, recent researchers studying language and cognition in childhood have highlighted Piaget's disregard of the role of language in the process of cognitive development and are attempting to demonstrate that a synthesis between the differing approaches of Vygotsky and Piaget is preferable (cf Segal, 1982).

Vygotsky's account on symbolic play
According to Vygotsky (1976) play is not the predominant type of activity at childhood, but a leading factor in development. Play continually creates demands on the child to act against his or her own immediate impulses. In play the child has to follow rules, inherent in the imaginary situation of play. For example, if a child is playing the role of a mother, then she has to follow rules for maternal behavior. Children playing with candies, which by the rules of the game represent something inedible, have to subordinate themselves to the rules and resist their impulses to eat the candies.

At every step in symbolic play the child is, thus, faced with a conflict between the rules dictated by the game and what he would do if he could act spontaneously. According to Vygotsky, in play the child often acts contrary to what he wants. He learns to follow the line of resistance by subordinating himself to the rules of the game. Therefore, a child's greatest self-control occurs in play, and his greatest cognitive achievements become possible in play situations.

This is not what Piaget considers. According to Piaget (1951), in symbolic play the child is dominated by his own
momentary needs, rather than by the demands of the external world or the rules of play. Accordingly, the playing child distorts reality by subordinating it to his own needs. Rather than developing by play, the child finds in symbolic play a situation where he is deliberated of the demands of life.

According to Vygotsky, then, the child moves forward essentially through play activity. Initially, the child's play situations are very close to the child's every-day life. For example, a child playing with dolls repeats almost exactly what her mother does with her and her sisters or brothers. Thus, a reproduction of the real situation takes place, however in a condensed form. There is very little imagery in the play situation.

Later on, the child creates an imaginary situation in his play. In this situation the child operates with alienated meanings. For example, when he transforms one object (a stick) to another (to represent a horse). In a very young child, with regard to Vygotsky, action dominates over meaning and is incompletely understood. At the preoperational level the situation becomes reversed. Now the meaning of action is basic, i.e. it is the structural determinant, while action itself retreats to second place.

According to Vygotsky, operating with the meanings of things is the determining factor which leads the child to abstract thought.

At school age this process is realized. Play now is increasingly converted to internal processes, turning into internal speech, logical memory, abstract thought, and fantasy. Also on this count Vygotsky and Piaget views differed. According to Piaget symbolic play is fading away at school age, and replaced by rule governed games and logical reasoning. According to Vygotsky, the rules of play are inherent already in symbolic play. Every imaginary situation contains, according to Vygotsky, rules for
behavior, although the rules are not yet formulated and laid down in advance.

Furthermore, Vygotsky argued, in contrast to Piaget, that symbolic play turns inward as the child grows older. In symbolic play the child learns to recognize consciously his own actions, and becomes aware that every object has a meaning. From the point of view of development, the fact that the child can create an imaginary situation and is aware of the meaning of it, can, according to Vygotsky, be regarded as a means of developing abstract thought. Thus, in Vygotsky's view, at school age play does not vanish, as Piaget thought, but permeates the child's attitude to reality. It has its own inner continuation in school instruction and rule-based work, and it enriches also the growing individual's creativity, imagination and other novel thought processes (cf. Levine, 1984).

Finally, the terms used by Vygotsky and Piaget referring to childhood play are not quite comparable. Vygotsky's term "imaginative play" appears to be a broader term than Piaget's "symbolic play" since Vygotsky's term includes language. According to Vygotsky the child's play develops at a later stage, that is, at three years of age versus Piaget's 18-month level. Vygotsky's imaginative play necessarily assumes that language is important during this stage of play development. Piaget does not clarify this point since some of Piaget's play categories do include language and some do not. As Segal (1982) puts it:

"In this sense, Piaget and Vygotsky are measuring different aspects of play, both of which involve the process of symbolization and abstracting, but one of which (namely symbolic play) is non-linguistic whereas he other (namely imaginative play) includes linguistic elements." (p. 114)

It is proposed by Segal (1982) that symbolic play may be considered as a subset of imaginative play. In our
empirical studies we are using the concept "symbolic play" in the broader sense described above.

2. The empiricist approach to representation

A specific feature of the empiricist approach is the assumption that mental representations are ultimately modality specific in character. In this sense the empiricist approach offers a major alternative to Piaget's theory of a single semiotic function for representation. One of the theorists from the empiricists school who has recently presented a theory of mental representation is Allan Paivio (1971, 1986).

Paivio's theory, called the dual coding theory, is based on the general view that cognition consists of the activity of symbolic representational systems that are specialized for dealing with environmental information in a manner that serves functional or adaptive behavioral goals. The most general assumption in the dual coding theory is that there are two separate cognitive systems - one specialized for the representation of nonverbal objects and events, and the other specialized for dealing with language. In contrast to Piaget, Piaget holds the view of one single representational system.

According to Paivio's dual coding theory, one system (the non-verbal or image-like) represents knowledge about the appearance of and emotions related to objects. For example, thinking of a dog, in this representational system, is activating stored images based on previous perceptions of dogs. These memory images may be somewhat schematic, but they share different sensory qualities of perception.

The other representational system (the verbal) represents language-based knowledge, consisting of associations and
relations among words. The word dog may activate associated words such as cat, superordinate words, such as animal, functions such as to pat, and so on.

The two systems of representation are, according to Paivio, assumed to be structurally and functionally distinct. In Paivio's (1986) own words:

Structurally, they differ in the nature of representational units and the way the units are organized into higher order structures. Functionally, they are independent in the sense that either system can be active without the other or both can be active in parallel. At the same time, they are functionally interconnected so that activity in one system can initiate activity in the other. (p. 54)

The two systems are, thus, both distinct and related. As far as the example "dog" above is concerned there exists a associative link between the image and the name of dog. The image of dog is associated with the word dog, and vice versa. The representation of the symbol "dog", includes activation of both representational systems.

Since words enter the verbal system, according to Paivio, an extra step is required to evoke the corresponding image. That step takes time. Conversely, when a person sees an object or a picture of an object, the image representation is first activated, and an extra step is needed to evoke the object's verbal representation. Even this step takes time.

However, Paivio argues that the between-system relation is not always symmetric, i.e. the interconnections between the verbal and non-verbal system are not assumed to be one-to-one, but rather one-to-many in both directions. For example, when a person looks at an object or a drawing of it, its name is, according to Paivio, automatically activated, even if it can take some time. On the other
hand, when a person hears a word naming a concrete object, the corresponding image is not necessarily activated.

Concrete objects are, thus, according to Paivio, represented both in the verbal and in the non-verbal representational systems. Words, referring to abstract entities, such as e.g. love or liberty, are, on the other hand, represented almost entirely in the verbal system. According to Paivio, the verbal system develops as a symbol system of words first mapped onto objects. As a function of time and through intraverbal connections it becomes autonomous, and capable of representing functions, relations, and structures that are abstract rather than perceptible. Thus, the verbal system is specialized for representing abstract knowledge, i.e. language-based knowledge, whereas the image system represents perceptual properties of objects.

According to Paivio, the development of the verbal system is based initially on a non-verbal representational system. This view is in general agreement with Piaget. However, when it comes to the claim, explicitly expressed by Piaget, that the growth of the verbal representational system depends on a non-verbal representational base, the theorists part. According to Piaget, although the verbal system is not independent of the non-verbal system during its early development, at some point, however, it becomes capable of functioning independently. The two systems can, according to Paivio, function both in parallel and in interaction with another.

Paivio's dual-coding theory can be viewed as an alternative to Piaget's theory of one single semiotic function for representation. The accumulating evidence, from empirical studies of children (Pellegrino et al., 1977; Potter, 1979), and from hemispheric specialization of function (Milner, 1971; Wapner et al., 1986; Weininger & Fitzgerald, 1988) is also consistent with the dual-coding
theory. Language functions are found predominantly in one hemisphere, usually in the left. Certain spatial abilities and other non-verbal representations are localized in the right hemisphere. However, any conclusion drawn from hemispheric differences is certain to meet with difficulties, since there is an interaction between the two hemispheres.

The evidence described above is thus still weak and speculative. Until there exists stronger evidence for the empiricist approach, proposing different representational systems we adopt Piaget's hypothesis of one single semiotic function for representation.

3. The nativist point of view

The approach taken by Noam Chomsky (1975, 1980) was that of a nativist position. Chomsky, a linguist from his earliest student days, views knowledge of certain facets of language as a separate, inborn property of mind, and not as one of several and parallel forms of the semiotic function. As a nativist Chomsky argued strongly for the doctrine of innate mental structures, proposing that knowledge of language derives from an innate "kernel" or "fixed" scheme. Chomsky admitted that such knowledge certainly requires a triggering environment, but there is no need for an active construction process, governed by the child's thought, as Piaget claimed. Nor are there separate stages of development based on changes in the child's mental capacities and based on interactions with the environment. According to Chomsky, language unfolds in as natural manner as, for example, the circulatory system.

Whereas Piaget considered human language as a product of the general cognitive development, Chomsky viewed language as a highly specialized part of human genetic inheritance,
largely separate from other human faculties. In Chomsky's view, language is a creative capacity immanent in the brain, reflecting the natural logic of mind, and is in no way intermingled (at least not at the start) with other cognitive capacities. In fact, Chomsky argued that young children can pick up one or more languages at an age when other cognitive capacities are still quite immature. In Chomsky's view, Piaget had played down the role of language.

On this point it has to be mentioned that Chomsky distinguished between language competence and language performance. Language competence is the ideal type of language knowledge that a person has in his mind. It is, according to Chomsky, governed by a set of transformational rules, which are abstract and logico-mathematical in character. Language performance, on the other hand, consists of all of the utterances an individual produces. Language performance is neither logico-mathematical nor abstract, but psychological, creative and concrete. When Chomsky is talking of innate mental structures for language or of how language develops, he is referring to language competence.

According to Piaget, the ability to represent knowledge is a constructive process that presupposes a series of actions upon environment. At the beginning of the preoperational stage this results in the emergence of the semiotic function. Chomsky is doubtful both about the constructive view of Piaget, and about the legitimacy of grouping together a number of representation forms into one symbolic function. In his view, language as a symbol system is not in any significant way influenced by specific behaviour acts, and should be radically dissociated from other symbolic forms (cf Gardner, 1982b).

According to Piaget, thought constitutes a broad set of capacities, and the roots of later forms of thought can be
located in earlier forms. From Chomsky's radically different point of view, language is divorced from other and earlier forms of thinking. Furthermore, according to Chomsky, each intellectual faculty is a separate domain, possible located in a discrete region of the brain, exhibiting many of its own processes and maturing at its own rate.

Chomsky had also reservations about the modes of proof Piaget adopted (Chomsky, 1980). More committed to operational definitions and logical specifications, Chomsky was uneasy with the absence of crucial tests for many of Piaget's conclusions. Incidentally, the doubts Chomsky raised about Piaget are raised by others against Chomsky's own work (cf. Paivio, 1986).

At some points, however, Chomsky's and Piaget's views converge. Both believe in the importance of a biological perspective. Both also share the conviction that important aspects of mind are working according to a coherent system of transformations (cognitive transformation rules for Piaget, and linguistic transformation rules for Chomsky).

Piaget and Chomsky share, thus, the belief that in order to understand the work of mind, one must search for underlying structures. For Piaget this meant, among other things, to map the laws of the semiotic function and the mental operations involved in it. For Chomsky it meant to unravel the rules of universal grammar in children's development.

4. The artistic approach to representation

There are several researchers (Gardner, 1973, 1979, 1982a,b); Levine, 1984; McNiff, 1982; Peacock, 1984; Perkins & Leondal, 1977) who argue that Piaget's hypothesis of a single underlying semiotic function is too narrow to
count for the processes involved in artistic creativity in children.

According to Gardner (1979), Piaget's hypothesis of a single underlying semiotic function rests on a too narrow end state for cognition, i.e. the domain of logical-rational thought. With regard to Gardner, children's drawings, paintings, play, gestural expressions and other "artistic" activities involve different processes of thought with their own evolution, than those described by Piaget.

In Gardner's (1977) view artistic cognition develops in a way in which the operative aspect of knowledge (i.e. concrete and formal operations) is not directly relevant. What is required is an increase in figurative knowledge, i.e. the ability to perceive details within a sensory modality, to retain sensory impressions, to acquire knowledge about the representation medium, and to be skilled in realizing effects in a particular medium.

For Gardner the dimension of figurativity/operativity appears to be crucial in much artistic activity and is of special consequence in differentiating artistic cognition from scientific cognition. Figurative cognition is more important in the arts than operative cognition, which in turn is important in scientific reasoning.

In development terms, in the early years of life figurative perception dominates. For a while, between the ages of six and eleven (during the concrete operational stage), increased operativity goes, according to Gardner, hand in hand with sustained figurativity. After that age individuals in our Western society display a steady and continued improvement in operative tasks. Gardner therefore asks whether a cultural emphasis on operative thinking has had an unintended consequence, a deleterious effect upon figurative capacities.
Since Piaget's theory of a single underlying semiotic function highlights the operative aspects of cognition and reflects an exclusive interest in the modes of cognition instrumental in scientific knowledge, it does, according to Gardner, not account for these kind of thought processes which make use of a different kind of logic.

Levine (1984) is criticizing Piaget for basing his hypothesis of the semiotic function, and especially the role of play in it, on the belief that Aristotelian logic is the sole basis for coherent, objective thinking. According to Levine the logic of play is not Aristotelian logic but the logic of metaphor. Metaphoric cognition allows for connection of "different" entities, not considered by the rational logic of Aristotelean (adopted by Piaget). Metaphoric cognition, permits, according to Levine, understanding that although two Gestalts (each composed of several relationships) seem to be mutually exclusive, they could be integrally related through a creative fusion.

Levine suggests then that the metaphoric logic used in play is perhaps the most fundamental tool which can be used by the child (or adult) during creative cognition. Contrary to Piaget, Levine suggest that play should be the framework used by children to explore their environment in a truly creative sense, and not as Piaget views it, a nonadaptive and subjective mode of cognition characteristic of the pre-operational stage of development.

Both Gardner and Levine are thus criticizing Piaget for his emphasis on rational thought and for his diminishing the thought processes which are central in children's "artistic"-like activities, such as play, drawing, gestural imitation and even in language when used in figurative sense. Their views are shared also by others (see for example Arnheim, 1979; McNiff, 1982; Peacock, 1984).
Dissatisfaction with Piaget's logical models extended to Piaget himself. In a book from 1980 (Piaget, 1980, cit. by Beilin, 1989) Piaget declared that he had been in error in putting too much emphasis on extensional logic. He argued that a new theory of meaning based on intentional logic was needed together with a revised version of his earlier extentional logic. The new theory of meaning that he never had the time to develop before his death does not indicate what would remain of his earlier version of logico-rational thought. However, Beilin (1989) argues that specific logics are not in the core of Piaget's research program and should be replaced as needed to accord with research data.

Concluding remarks

The alternatives offered to Piaget's hypothesis of a single semiotic function for representation, and the critical comments upon it, can be summarized and interpreted as follows:

First, the question whether there is an innate structure underlying all human behavior, or whether the child has to learn everything from environment, reflects the debate between the nativists and the empiricists. This has been going on from the seventeenth century, with Decartes and Locke, and will surely be continuing for a long time yet to come. The nativists, exemplified in the present context by Chomsky, hold the view that all intellect is present at birth, in the form of innate mental structures, and has only to unfold. The rival empiricists position, exemplified here by Paivio, states that all knowledge already exists in the world, just waiting to be etched into the blank mind of the infant.
Piaget's interactionistic point of view, attempts a solution to the nativist-empiricist debate through his cognitive theory where the interaction between individual and the world is in focus. According to Piaget, the child is constructing his own knowledge, his own symbols and his own world-view through his own overt or covert actions vis-a-vis the external world. This is a theoretical point of view with which we sympathize, and take as our own point of departure.

Second, the issue concerning the relation between language and thought - or in the present context whether language is one form of the semiotic function - is an extremely complex one. The arguments of Vygotsky, the view of Bruner, the dual-coding theory of Paivio, all highlight the controversy.

After having wrestled with this issue for a long time, our point of view is that language may very well be one form of semiotic function, deriving from thought and structured by it. However, we want to point out (1) that the empirical evidence for this is still lacking and (2) that the concept of "thought" has not necessarily been considered as consisting only of logico-mathematical type of thought, as Piaget viewed it, but can include different modes of thought - such as visual, auditory, kinesthetic, and so on.

Third, the narrow end-state for cognition - hold by Piaget and criticized by those who study artistic development and growth, exemplified here by Gardner and Levine - is a serious limitation in Piaget's theory. There is a range of symbolic activities in which both children and adults partake, without being guided by logico-mathematical thought. The study of the semiotic function has, in our opinion, to count both with the rational-logical thought and the nondiscursive, intuitive and creative kind of thought processes.
The hypothesis of the semiotic function can be studied either cross-sectionally or longitudinally. In cross-sectional studies the researcher limits her (his) investigation to a static analysis made at a single point in time. In longitudinal studies she extends her studies to deal with the developmental aspect and its changes over time.

Most research on the different manifestation forms of the semiotic function has been carried out cross-sectionally. The advantages of cross-sectional studies are that these are often easy to conduct and both time- and cost-saving. Cross-sectional studies are useful in defining the state of the problem. The problem in the present case was to explore the question whether there could exist one common underlying semiotic function for representation or not. Furthermore, cross-sectional studies are important as the benchmarks to which subsequent studies of process and change may be referred.

Longitudinal studies, on the other hand, are used to observe the developmental processes and the changes in these. Regarding the semiotic function, the researcher can (by means of longitudinal studies) delineate common structural developmental principles and -stages in different representation modes of the semiotic function. This can be done although these principles and stages do not come into play in all domains at the same time.

Further, by means of longitudinal studies individual differences can be investigated. Individual differences are often striking in everyday encounter with young children,
however, these are elusive to the investigator. They are difficult to articulate, hard to measure reliably, and they often prove unstable over time.

Longitudinal studies in the area of symbolic functioning are rare. One of those, investigating the question: "Is the course of symbolization similar across children, or are there instructive differences characterizing the manner in which individual children achieve symbolic competence?", is a study carried out by Wolf and Gardner (1979).

The weaknesses of longitudinal studies are, that the sample sizes are often small, which makes the conclusions drawn from the data quite uncertain.

An additional methodological point to be noted has to do with two types of emphasis - exploration vs. hypothesis-testing. Piaget himself used a combination of these two methodological approaches. His clinical-interview method was based both on the hypotheses he was testing and the observations and interpretations he made of the child's spontaneous behavior.

Our empirical studies were experimental and one of our objectives was hypothesis-testing. At the same time, however, we were observing the child's spontaneous behavior whereby we tried to learn as much as we could about the child's reasoning. This was done, (1) because our knowledge of the semiotic function was still vague and incomplete, and (2) because the child's representations in e.g. drawing would have been incomprehensive without the observation of the total context in which the representation took place.

The main aim of the present thesis was to investigate the parallel manifestations of the semiotic function, indicating whether there could exist one common semiotic function or not. According to Piaget's hypothesis, the child's representations in different representation modes
should, at a certain development stage, be constituted in such a manner, that they have a common structure and are constructed according to similar representation rules. This hypothesis could in principle be explored by cross-sectional studies, which was also the method adopted in the present thesis.

Nevertheless, there are several difficulties which have to be considered and which made it difficult to draw conclusions from our empirical studies. From a theoretical point of view the concept of the semiotic function is rather abstract, and hence difficult to operationalize. Since Piaget himself did not outline his hypothesis of the semiotic function in detail, the readers are left with a vague idea of what the hypothesis entails, and the process by which its different manifestation forms develop.

After having wrestled with this issue for a long time we nevertheless felt that we were left with an unsolved problem. The hypothesis of the semiotic function seems to constitute a closed system with no way out of the system. This means, that when an experimenter investigates the relations between any two of more manifestation forms of the semiotic function he or she has to use an additional manifestation form for this purpose.

In our empirical studies we used language (the fifth's and most developed manifestation of the semiotic function) to investigate two others, less developed manifestation forms. The two representation forms investigated in each study were thus compounded with an additional one (language), and consequently it was difficult to draw any valid conclusions about the relations between the two forms investigated, and about the existence of a unitary semiotic function.

The same difficulties arose the other way round. When the subjects solved the test-tasks in our different studies, they used language, thus inserting an additional
manifestation form of the semiotic function to solve the task and to explain how they were doing it.

These difficulties are at present hard to solve. It might even be argued whether the hypothesis of the semiotic function is in principle testable at all. And to the present time nor has it been tested. Nevertheless, the difficulties associated with the semiotic function should not be taken to imply that the hypothesis is untestable. The issue is surely a complex one. However, it is a challenge for future to create or make use of research strategies in which Piaget's hypothesis can be most fruitfully addressed. Observing the children solving different tasks, as Piaget did, might for example give some fresh ideas how to solve the methodological problems in the present case.
STUDY 1. Relations between drawings and play-constructions in four and six-year-old children

We started our empirical studies by investigating the figurative aspect of representation (the spatial arrangements and coherence of representation) in two of the representation mode of the semiotic function. For the first study drawing and play-construction were selected. The test task, a lengthy narrative, was presented to all the children. The task was relatively long and, from an experimental point of view, vaguely structured, which gave quite an amount of freedom for the child to construct his representations.

Considering earlier research we can state that much has been written about both drawing and play of young children. Nevertheless, there is very little research in which these both representation forms (as manifestations of the semiotic function) are compared for the same children's representational ability. In the present context we review earlier findings in the separate spheres of drawing and play, thereby focusing on the character of the child's symbolic forms and these arrangements in space.

Drawing. Regarding drawing Piaget himself (Piaget & Inhelder, 1967, 1969) relied heavily upon the description that had previously been provided by Luquet (1913, 1927). In incorporating Luquet's account of the development of drawing within the more general framework of his own cognitive-development theory, Piaget pointed out that Luquet's description implies that young children's drawings are always realistic in intent. This means, that the child begins by drawing what he knows about an object long before he can draw what he sees. For example, when a child draws a hand with five fingers, he does it because he "knows" that
a hand has five fingers. This kind of interpretation states that the child's drawings reflect his intellectual level.

Arnheim (1954, 1969) is among those who have argued against the so-called intellectualistic view of children's drawing. According to him, the child draws what he sees, rather than what he knows, even if he usually sees more than he draws. This means, for example, that when a child draws a hand and omits some fingers, he relies, according to Arnheim, on a visual concept of the hand, consisting of a round base, i.e. the palm, from which fingers grow out, and not on the intellectual knowledge of a hand having five fingers.

Children's drawing can, thus, be interpreted along two lines, (a) as assessing the child's thought processes (Piaget) or (b) as assessing the child's perceptions (Arnheim). Research indicates, however, that the matter is neither easy nor uncomplicated (Barrett, 1983; Franklin, 1973; Gardner, 1982b; Golomb, 1973; Peacock, 1984). The child's experience of the world is surely a good deal more differentiated and systematically organized than his early representations let to assume. Thus, explanations which state that the child "draws what he sees" are inadequate. On the other hand, the child does not always "draw what he knows" either.

At this point Arnheim calls attention to an important matter, not mentioned by Piaget, namely to the "role of the medium". According to Arnheim, in the process of representation, specific discoveries of understandings of the medium play a central role. For example, when a child draws a picture, the symbols he creates in this process are neither solely reflecting his thinking nor his seeing, but have to be considered as genuine inventions in a specific medium. Symbolization in a graphic medium is, thus, an impressive achievement, at which the child arrives only after laborious experimentation (Golomb, 1973; Gardner, 1982a,b; LeCronFoster & Brandes, 1980).
Despite the differences in theoretical points of view, most researchers (Arnheim, 1954, 1974; Barrett, 1983; Golomb, 1973, 1974; Goodnow, 1977; Goodnow et al., 1986; Piaget & Inhelder, 1969; Smith, 1979), however, agree on that the child's very first representative drawings most frequently consist of global, undifferentiated forms and shapes, chiefly marking the over-all qualities of the drawn objects. Both the early undifferentiated drawings and the later more complex and coherent ones are therefore regarded as symbols or signifiers, rather than imitative copies of reality. Accordingly, the children's drawings do not have to show any specific likeness to what they symbolize.

Regarding the spatial arrangements in children's drawing, a number of investigators have studied the complex evolution from early scribbling to pictorial representation (Barrett, 1983; DiLeo, 1970; Freeman, 1980a,b; Golbeck et al., 1986; Golomb, 1973, 1974; Goodnow, 1977; Kellog, 1969; Luquet, 1913; Leeds et al., 1983; Smith, 1979). Common to their findings is the notion: the younger the child is, the more incoherent his drawings.

Children four years or younger seem to be quite insensitive to how the different parts in a drawing should be related, and they do not seem to realize the importance of drawing all the objects which make up the integral parts of the picture. The children may, for instance, draw only some of the objects, or parts of the objects while omitting others, or parts of them, despite each of the objects or their parts being equally important for the whole picture. It seems, as if the space of the page is for the young child an arena for action, rather than for representation.

At the age of four the child is still unable to coordinate properly the various elements of his graphic product, and he may instead simply juxtapose these elements instead of arrange them into a whole picture. The basic objects are drawn blended and confused, indistinguishable from each
other. There is no coordination of parts and objects in space, and the relations "inside and outside" are not preserved. Thus, trees behind a house may be drawn above the house, buttons may be drawn along the body, a roof inside the house etc. This stage is sometimes called the stage of "synthetic incapacity" (Leeds et al., 1983; Piaget, 1951; Piaget & Inhelder, 1969).

The young child's inability to draw a coherent picture has to do with his understanding of space (Leeds et al., 1983; Piaget & Inhelder, 1967, 1969; Robinson & Robinson, 1983) and also with the medium used for representation (Arnheim, 1954; Gardner, 1978, 1982a,b; Golomb, 1973, 1974; Seidman & Beilin, 1984). With respect to space the young children's drawings show no awareness of visual perspective or metric relations. However, they show topological relationships: promixity, separation, enclosure, etc. With respect to medium, the evolution of young children's drawing proceeds from early nonsymbolic, motorically dominated use of the medium, to mastery of the basics of representation at the age of five or six (London, 1982; Seidman & Beilin, 1984; Smith, 1979).

As the child grows older, at about the age of six or seven, the symbolic character of the drawn objects decreases and is replaced by more realistic looking copies of reality. As a rule, children at this age are capable to draw a coherent picture of their representation. During this stage, the child's drawings usually depict "everything that is there", but the drawings still lack proportions, a unified perspective, and distance relationships. Thus, a house might be depicted showing all sides, objects intended to be inside a solid objects could be shown and several viewpoints might be represented. According to Piaget and Luquet this is the stage of "intellectual realism" (Arnheim, 1954; Di Leo, 1970; Golomb, 1973, 1974; Goodnow, 1977; Kellog, 1969; Leed et al., 1983; Luquet, 1913, 1927; Morss, 1987).
Considering drawing it is important to note that an analysis of young children's drawings may give quite a misleading picture of children's actual representational ability, if one does not take into account the verbal context in which the drawing process takes place. Forms, shapes, "tadpole-men" and the like would be totally incomprehensible if they were not supplemented by the child's explanations of what these "signifiers" stand for. At this account several others share this view (DiLeo, 1970; Golomb, 1973, 1974; Kellog, 1969; London, 1982; Robinson & Robinson, 1983; Seidman & Beilin, 1984).

Play. With regard to play Piaget (Piaget, 1951; Piaget & Inhelder, 1969) distinguished between symbolic play proper and symbolic play-construction. Symbolic play represents the child's transformations of reality in the direction of wishfulment, in which the child may quite freely assimilate objects to the needs of the self, without any concern for their objective characteristics. Play-construction, on the other hand, has a more work-like quality. It bridges the development from sensori-motor play to work-like activity during middle childhood, and involves accommodations and spontaneous intelligent activities. In the present study our interest is on play-construction.

According to Piaget (1951) the symbolic play-constructions of the child change their character between the ages of four and seven. First, there is a progressive increase in coherence in the play-constructions and, second, the symbols used by the child become increasingly realistic, i.e. they are chosen so that they approximate a straightforward imitation of reality. Before the age of four the child is unable to construct spatially coherent representations, which is true in free play-observation situations without any instructions (Bruner et al, 1966; Golomb, 1979; Kamp, 1947; van Wylick, 1936; Vygotsky, 1976) and in play-construction tasks with given
instructions (Golomb, 1979; Morss, 1987; Piaget & Inhelder, 1964; Shotwell et al., 1980; Wolfgang & Phelps, 1983).

Only at the age of about seven is the child able to construct a spatially coherent representation with adequate topographic relations between the included objects (Kamp, 1947; Light, 1983; Piaget, 1951; Piaget & Inhelder, 1964, 1969; van Wylic, 1936;).

The findings described above suggest that the development of children's representations in drawing are related to those in play-construction. The similarities are pointed out both by Golomb (1974) and Goodnow (1977). Kamp (1947) and Piaget (Piaget & Inhelder, 1969) stressed the correspondence between childrens' play-constructions and the Luquet's (1913, 1927) development-sequence for drawing. This is of course what Piaget's hypothesis of a unitary semiotic function would lead us to expect. However, as far as we know, no study has directly investigated the relations between these two modes of representation, using the same children and the same test-task. Consequently, it is not possible to ascertain what the relations between these two representation modes are.

The purpose of the present study, therefore, was to investigate the relations between drawing and play-construction with the same children, thus enabling us to see whether these modes are related as would be expected from Piaget's notion of a single underlying semiotic function. Specifically, the purpose was to investigate how children's representations are structured, emphasizing primarily their spatial coherence (i.e. the figurative aspect of representation), and the way in which this structure is reflected in drawing and play-construction. For this purpose the experimental groups were tested with the same test-task, which was presented verbally.

The age groups in the study comprise four- and six-year-old children. Pilot work revealed that children below the age
of four were too young to participate in this kind of investigation, because they were incapable of responding to task instructions. Children above the age of six were too advanced for the problem in question.

The hypothesis for the study may be summarized as follows:

The 4-year-old children are unable to construct a spatially coherent representation of the test-task both in drawing and in play-construction. Instead they will draw and/or arrange the objects into collections.

The 6-year-old children, on the other hand, should be able to construct a spatially coherent representation of the test-task both in drawing and in play-construction.

It is important to note that the task demands differ between drawing and play-construction as the latter method is usually employed. In drawing, the child has to transform a verbally evoked representation into a two-dimensional graphic one. In addition, he has both to invent and produce the "signifiers" necessary for that purpose. In play-construction all the representative objects (toys) are already in front of the child's eyes, and he has only to ask for those which correspond to the verbally evoked representation in his mind. To construct a representation may therefore be harder in drawing than in play-construction.

To shed some light on this problem an additional condition was introduced in which the subjects had to ask for toys for their constructions, rather than just choosing them from a set of visible toys. This condition is midway between drawing and the traditional form of play-construction in that it requires the subject to recall the items to be used, but does not require him to actually create them as he does in drawing.
The hypothesis lead us to expect that the results will be similar in all three conditions with respect to their structural properties.

**METHOD**

**Subjects**
Eighteen middle class children from a nursery school in Boden (a small town situated in the north of Sweden) served as subjects. Nine children (4 boys and 5 girls) with a median age of 4.6 years (3.11 - 4.10) were assigned to the 4-year-old group, another 9 children (3 boys and 6 girls) with a median age of 6.7 years (5.9 - 7.1) to the 6-year-old group.

**Test-task**
A narrative was used as a test-task. The length of the narrative was 320 words and the reading of it required about two minutes. The test-task described an outdoor scene as follows:

In the middle of the scene there was a lake. On one side of the lake there was a red cottage surrounded by a green fence. Behind the cottage were two trees. The cottage was inhabited by two children. On the other side of the lake there was a big white church. On one of the remaining sides of the lake there was a circusring surrounded by a big wall. Inside the circus there were a number of animals. In the middle of the circus a king was riding a black horse and beside him the queen, riding a big elephant. The king's hobotgoblin stood near the circus wall watching a monkey who was asleep on a red pillow. The queen's angel sat beside her in a small carriage pulled by a dog. In the lake there was a rowing-boat with a prince and a princess sitting in it. A big dangerous crocodile was swimming beside the boat.
Material
Sketch-pad paper and pencils were provided for drawing. The play-material included about twice as many small representative toys as were needed for the problem. In addition each child was given a rectangular piece of cardboard (80 x 60 cm) on which to build the scene.

Experimental conditions
A mixed factorial design (age x experimental conditions) was used with the experimental conditions as a within-subject factor. The order of the three experimental conditions was counterbalanced according to a latin-square arrangement. The three experimental conditions were as follows:

1. Drawing. The subject had to make a drawing of the scene, described by the test-task, using the pencils and the sketch-pad paper provided.

2. Building by asking for toys. The subject had to build the scene, described by the test-task, on the rectangular cardboard, asking the experimenter for the toys needed for this purpose. Under this conditions the play-material was kept out of sight of the subject.

3. Building by choosing toys. The subject had to build the scene on the cardboard by choosing the toys from a collection of toys, i.e. under this condition the subject had free access to the whole play-material. Since the play-material contained about twice as many toys as were necessary for performing the test-task the subjects were told that some of the toys were superfluous but could be used for other stories.

Procedure
The subjects were tested individually. In order to give the subjects an opportunity to get acquainted with the experimenter and the test-task, before the main sessions
each subject was approached on three different occasions separated by one half to one day. Each time the test-task was read to the subject. During these preliminary sessions, the experimenter also made sure that the subjects understood the concepts in the story by asking them to give definitions of the following kinds: "A church is a place where one sings, gets married, etc."; "A cottage is a little house to live in during the summer,"; "A circus is a place where you have animals and/or do tricks, etc." All concepts unknown to the subjects were explained and exemplified, until they managed to define them properly.

The test-sessions took place on three consecutive days, no more than five days after the subjects were first approached. During test-sessions the experimenter and the subjects were seated alone facing each other in a room adjacent to the common nursery hall. At the beginning of each session, the test-task was presented and the subject required to retell it, i.e. to tell all he/she could remember of the story. The subjects having difficulties retelling the story were prompted by questions like: "What happened then?"; "Was there anything else in the story?"; etc. Directly after retelling, the subject was required to perform the drawing or the play-construction. There was no time limit.

The subjects' retellings of the test-task and the conversation that took place between the experimenter and the subject during drawing/play-construction were tape-recorded. A typed transcript of every tape-recording, referred to below as the subject's protocol, was made on the same day. In experimental condition 1 the subject's drawing together with the protocol served as documentation of his/her performance. The different objects drawn were numbered and listed at the end of the protocol. In the experimental conditions 2 and 3 the test-task scene constructed with toys was photographed. The photo together with the protocol served in these cases as documentation of each subject's performance.
Dependent Variable
For each subject and experimental condition the degree of spatial coherence in representation was obtained as described below in order to provide an overall measure, which will serve as the main dependent variable in this study.

Beside that we were interested in the context in which the representations took place, and observed how the subjects used the available space in different representation media, and created or used symbols in these media. These results served as an additional indicator of the figural aspect of representations in different representation modes.

Categorization scheme for the degree of spatial coherence. The scene described by the test-task was divided into three thematic groups (TG), every one of these possessing a spatially coherent structure as follows:

TG 1
A cottage surrounded by a fence with two trees behind the house.

TG 2
**Alternative a:** A circusring surrounded by a round wall with a number of animals in it. A king and a queen riding in the middle of the ring and an angel sitting in a carriage drawn by a dog.

**Alternative b:** A king and a queen riding, on their way to a circus enclosure, followed by a number of animals and beside them an angel sitting in a carriage drawn by a dog.

TG 3
A boat with a prince and a princess sitting in it floating in a lake with a crocodile swimming beside it.
These thematic groups were divided, in turn, into simple relations of the following kinds:

(1) a cottage surrounded by a fence
    a cottage with two trees behind it

(2) a circusring, surrounded by a wall, with some
    animals in it
    a king and/or a queen riding an animal
    an angel sitting in a carriage
    a dog drawing a carriage

(3) a prince and/or a princess sitting in a boat
    a boat in the lake
    a crocodile in the lake

The rest were considered as "isolated objects".

The degree of spatial coherence in representations was defined in terms of the following hierarchical classes:

Class 1 - includes all isolated objects, drawn or toy-objects, randomly placed beside each other and/or mixed with pairs of interrelated objects of the type called "simple relations" described above.

Class 2 - includes both isolated objects and related ones, i.e. all that can be considered to belong to class 1. In addition, it has to include one optional TG of the three TGs described above.

Class 3 - includes class 1 above and two of the three TGs described above.

Class 4 - includes all three TGs, ordered in a juxtaposed manner, i.e. without considering their correct spatial positioning.
Class 5 - represents a totally coherent representation of the test-task.

Scoring procedure for the degree of spatial coherence.
Inspection of the data showed that there were a lot of incorrect objects, i.e. objects not mentioned in the story, especially in the younger age groups' representations. When calculating the degree of spatial coherence, no attention was paid to the existence of those.

The material on which the calculation was based in drawing comprised: the subjects' drawings, the list of drawn objects, and the subjects' protocols. In building by asking for toys and in building by choosing toys, the photos of the end-products together with the subjects' protocols were used.

For each age group and experimental condition two independent raters made the classifications for the degree of spatial coherence. The mean interrater reliability determined by Pearson r coefficient between the author's classifications and those of the other rater was for the 4-year-old group \( r = .89 \) and for the 6-year-old group \( r = 1.00 \).

RESULTS AND DISCUSSION

Degree of spatial coherence in retelling
By way of comparison, the degree of spatial coherence in retellings after the first, the second and the third presentation of the test-task was calculated in the same way as for drawing and play-construction but with objects replaced by words. Number of subjects attaining different degrees of spatial coherence in the different age groups are given in Table 1.
Table 1. **Number of subjects in each age-group attaining different degrees of spatial coherence in retelling the test-task after the first, the second and the third presentation.**

<table>
<thead>
<tr>
<th>Age-group</th>
<th>4-years-old</th>
<th>6-years-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation order</td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>Degree of spatial coherence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Class 2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Class 3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 5</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

As can be seen, the degree of spatial coherence is much higher in the 6-year-old children than in the 4-year-old children. Furthermore, there is no indication that the degree of spatial coherence changes across presentations.

**Degree of spatial coherence in drawing and play-constructions**

As revealed by Table 2, which shows numbers of subjects in each age-group attaining different degrees of spatial coherence in drawing and play-constructions (building by asking for toys and building by choosing toys), there is the same degree of spatial coherence in both drawing and play-construction in the 6-year-old group. In the 4-year-old children the representations in building by asking for toys are somewhat more coherent than those in drawing and in building by choosing toys. As can also be seen, the degree of spatial coherence is much greater in the 6-year-old children than in the 4-year-old children; in the former group all subjects fall in the two highest classes of spatial coherence, in the latter they fall in the three lowest classes with virtually no overlap between the age groups.
Table 2. Number of subjects in each age-group attaining different degrees of spatial coherence in drawing, in building by asking for toys, and in building by choosing toys.

<table>
<thead>
<tr>
<th>Age-group</th>
<th>4-year-olds</th>
<th>6-year-olds (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental condition</td>
<td>Drawing by asking for toys</td>
<td>Drawing by asking for toys</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of spatial coherence</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 2</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Class 4</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Class 5</td>
<td>1</td>
<td></td>
<td></td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

(1) One subject could not be motivated to take part in the last session, which in his case was drawing.

In order to shed further light on the question whether the degree of spatial coherence is similar in drawing and play-construction, Table 3 shows number of subjects in each age group attaining the same degree of spatial coherence in all experimental conditions. By way of comparison, the same data are given for retellings after the first, the second and the third presentation.
Table 3. **Number of subjects in each age-group attaining the same degree of spatial coherence in all retellings and in all experimental conditions (drawing, building by asking for toys and building by choosing toys).**

<table>
<thead>
<tr>
<th>Age-group</th>
<th>Retellings</th>
<th>Drawing/play-constructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>6-year-old</td>
<td>8</td>
<td>7</td>
</tr>
</tbody>
</table>

As can be seen from the table, nearly all subjects in the 6-year-old group attain the same (high) degree of spatial coherence in all retellings and experimental conditions, whereas in the 4-year-old group only 4 and 2 subjects, respectively, fulfil this criterion. There is thus a ceiling effect in the 6-year-old group, indicating that the test-task might have been too easy for them.

**Using space in different media**

In play-construction both the 4- and 6-year-old subjects used the cardboard as ground and placed the toys or groups of toys on it quite correctly in space. Even in the 4-year-old group the cottage and the church were, for example, placed opposite each other, the trees were placed behind the house, the fence surrounded the cottage, and so on. None of the subjects placed toys outside the cardboard.

In drawing, on the other hand, 4 subjects of 9 of the 4-year-old subjects used more than one sheet of paper to represent the test-task. (3 subjects used 4 sheets, and 1 subject used 9 sheets). In the 6-year-old group 3 subjects of 8 used more than one sheet to represent the test-task. (1 subject used 2 sheets, 1 subject 3 sheets and 1 subject 6 sheets). Those subjects, in both age groups, who used
more than one sheet of paper started out with too large representative symbols, and when they discovered that they were out of space, they simply asked for more paper.

Considering orientation in space there were also some differences in the two representation modes. In drawing the 4-year-old subjects related parts of their drawings to one another along a single axis or along the horizontal axis of the paper. Furthermore, the subjects worked from one item to the next, relying on one unit as a reference point for an adjacent one, rather than considering a set of items as a whole. Several parts of the drawing could therefore be linked up to one another without any special principle, neither spatial nor temporal. This was not the case in play-constructions, were the representative objects were placed on cardboard plate according to axes of coordinates, as was described above.

In the 6-year-old group the subjects were able to use an overall point of reference for all of the units in their drawing, thus picturing different objects opposite each other, beside each other, behind each other, and so on. However, although the drawings of the 6-year-olds were spatially coherent, 6 subjects of 8 still used mainly the horizontal axis of the sheet as a groundline for their drawings. About half of the subjects used also a mixed perspective, i.e. some objects or groups of objects were oriented along the horizontal axis, while others were seen from above or turned round so that they faced each other. These findings are in close agreement with what could be expected by Luquet's theory.

Some of the 4-year-old children avoided overlapping space and could, therefore, use another sheet of paper to draw the objects which were behind the objects drawn on the first paper. For example, the subject could draw the two trees, which were behind the house, on another sheet, commenting his problem solving by a statement as follows: "You can not see the trees from here".
About half of the subjects in this age group made use of including principles, drawing people inside the house, babies in the bellies, etc. In play-constructions similar principles could be observed in still a higher degree (7 subjects of 9). The subjects could, for example, place a table and some chairs outside the house, saying that the furniture was inside the house. Or, they could ask for beds for the people living in the house, and placed the furniture outside the toy-house, commenting the operation by a statement: "You cannot get inside the toy".

In the 6-year-old group these principles, described above, were no longer used, neither in drawing nor in play-constructions.

Creating and manipulating symbols in different media
Analysing our subject's representations in drawing, we could see that the 4-year-old subjects' symbols were both physical and expressive. This means, that the subjects tried to symbolize the action sequences of the test-task story, rather than the static qualities of the representative symbols. Thus, the king who was riding, was drawn with expressive lines referring to movement. A motor-rhythmic, zigzag "scribble" was called grass, water or rain, or was just indicating movement from one place to another. In forming symbols, the 4-year-old subjects were, thus, relying more on motoric aspects and on qualities of affectivity than on the physical-technical aspects of the symbols. It appears, therefore, that the 4-year-old subjects were not yet concerned with pictorial representation proper, but were engaged in drawing as a form of action. As a rule, the graphic forms of the children in this age group were identified verbally first after the child had stopped drawing. The children could even rename the drawn objects, especially when these did not look like the real ones. These findings, described above, agree well with Piaget's theory (Piaget, 1951;
Piaget & Inhelder, 1969), and also with results obtained by others (Golomb, 1973; Leeds et al., 1983; Smith, 1979; Werner & Kaplan, 1963).

In play-constructions the discrete structural nature of the toys prompted relations in space and portable objects to a considerable greater degree than the graphic forms in drawing. However, in contrast to drawing, the subjects in the 4-year-old group made few attempts to substitute one object with another (compare renaming in drawing), or to move the objects once they had found a proper place for them. Nevertheless, even in this representation mode the subjects often pushed the toys around on the cardboard plate, accompanied by imitative action movements and sounds. In contrast to drawing, these activities were carried out before the representation process was finished.

In the 6-year-old group the symbols in different representation media (graphic symbols and toys) were treated in a more similar fashion. In drawing the subjects' graphic symbols were more realistic looking copies of reality, devoid of expressive motoric qualities, and in both media the subjects were focused on the construction process as problem solving, rather than on the playful activities which accompanied the younger age groups' representations.

CONCLUDING DISCUSSION

The results of this investigation are in agreement with the hypothesis of the study, that the 4-year-old children are unable to construct a spatially coherent representation of the test-task, both in drawing and in play-construction, while the 6-year-old children are able to do so.

The main results are also in general agreement with the hypothesis that the figurative aspect of representation (the spatial coherence) is similar in both drawing and play-construction. As far as the 6-year-old group is
concerned, the results showed that there is a high degree of similarity in the structure of spatial coherence in both representation modes. That is, the 6-year-old subjects were able to construct spatially coherent representations of the test-task, both in drawing and play-construction, and their representations were similar in this respect in both kind of conditions.

In the 4-year-old group, on the other hand, the representations did not have much coherence in either drawing or play-construction. That is, the 4-year-old children were not able to construct spatially coherent representations of the test-task in either representation modes. The findings above are in line with earlier research (Freeman, 1972, 1980a,b; Golomb, 1973, 1974, 1979; Goodnow, 1977; Kamp, 1947; Morss, 1987; Piaget & Inhelder, 1964, 1969; van Wylick, 1936).

Since the degree of coherence tends to be similar in drawing and play-construction for both age groups, this finding indicates that there could be an underlying common function for representation in these two representation modes. However, since the two age groups differ in the overall degree of coherence, this indicates that this function could be less developed in the four-year-olds than in the six-year-olds.

Although the present results so far are in accordance with previous findings, they do not explain why the 4-year-old subjects' representations have such a low degree of coherence. In previous research the stimulus material has usually been well defined, such as to draw a human figure (Freeman, 1980a; Golomb, 1973; Goodnow et al., 1986) or to play such sequences as to go to the pet shop, feed a baby, build a house, etc. (Golomb, 1979; LeCronFoster & Brandes, 1980). There is, as far as we know, no experiment conducted where the same narrative is used as the test-task in these two representation modes.
In order to explain the obtained results there are thus at least three alternatives to the hypothesis that the 4-year-olds drawings and play-constructions express a lower degree of development of the semiotic function.

First, it may be that the test-task was too demanding, containing 24 items, or that the scene described by the test-task was too unfamiliar to the 4-year-old subjects. If so, the subjects' failure to represent the test-task in a coherent way is a problem of method. This aspect may be investigated by replacing the test-task with an easier one.

Second, it may be that the 4-year-old subjects' linguistic comprehension of the test-task was too poor, which in turn was reflected in their representations in different experimental conditions. As can be concluded from their retellings (see Table 1) the 4-year-olds' retellings can not be considered as coherent decontextualized linguistic narrations of the test-task. Rather they give an expression of a fragmented reproduction of different key words in the verbally presented task. Nevertheless, when the subjects actually were constructing their representations in different representation modes their continuous comments revealed that their comprehension of the test-task exceeded their retellings, and they seemed aware of the test-task as a coherent narrative with different themes.

Third, it may be that the external manifestations of the semiotic function have not yet reached beyond the field of the 4-year-old childrens' spontaneous activity. In this case it could be considered, as Piaget puts it, as a problem of décalage, i.e. temporal discrepancies in the appearance of mental processes (Piaget & Inhelder, 1971). That is, what the young child has learned on the plane of action, he must now restructure on the plane of thought. Considering the present findings, it could very well be that the restructuring process is not developed enough to
produce visible results (cf. Franklin, 1973; Robinson & Robinson, 1983). However, this is an instance where considerably more research is required.

Another point showing striking similarities between the representation modes had to do with principles used in constructing representations. According to Luquet (1913, 1927) there is a stage of development in children's drawing where the drawings tend to include all of the typical attributes which the child knows serve to exemplify the objects which he is attempting to draw. This stage is termed by Luquet as the stage of "synthetic incapacity" and is often described as: "the child draws what he knows rather than what he sees".

The obtained results fit well into the Luquet's stage theory, not only in drawing but in play-constructions as well. The 4-year-old subjects made use of including principles, i.e. representing what they knew rather than what they saw, in both representation modes. In drawing they drew people inside the house, in play-constructions they placed the furniture outside the house, since it was in this case impossible to get inside the toy-house.

Moreover, according to Luquet this stage starts first by about the age of five years. The present results indicate that this stage of development could start at an earlier age, since our 4-year-old subjects used these principles in their representations. This way to represent the task was even more articulated in play-constructions than in drawing. The results are, then, in disagreement with Arnheim (1954) who states that "the child draws what he sees, rather than what he knows", and in agreement with the Piagetian line of research (Piaget & Inhelder, 1967).

So far the discussion of the results has been about the similarities in the two representation modes. Considering the obtained differences in results in the two
representation modes, it can be assumed that these have to do both with the representation media and with the task demands.

As far as the representation media is concerned, drawing presents a graphic medium which seems considerably harder to master than play-construction. In drawing the child has to invent the symbolic forms himself and find graphic means to create a visual resemblance between his drawing and the image of the test-task. The child has thus to impose his understanding of the task upon the medium forming it to serve his purposes. To come to grips with the representation medium is a process of continuous experimentation, invention, and discovery, involving a great deal of effort on the part of the young child. Similar notions are made also by others (Arnheim, 1954, 1969; Barrett, 1983; Cox, 1981; Gardner, 1979, 1982a,b; Golomb, 1973, 1974; Peacock, 1984; Shotwell et al., 1980).

In play-construction the symbols are already ready-made and the child has only to construct a spatially coherent representation of them (cf. Shotwell et al., 1980). Thus, the representation medium is considerably easier for the child to master. The obtained differences in our results can, therefore, to a certain degree be explained by the media effects that are at play in the two different representation modes.

Regarding the task demands, it can be stated that despite the fact that the same test-task was used in the two representation modes the task demands differed between the two modes. In drawing the definition of the test-task was relatively vague and ambiguous. The burden was on the child to decide what kind of representation will be satisfactory. Moreover, the child was faced with a situation which required that he himself invented the forms. Thus, the situation could be defined as lacking a definite structure and containing an immense amount of freedom for the child.
In play-constructions the child was provided with toys which he was acquainted to and which were, more or less, realistic copies of the real objects. The task was, thus, relatively well defined and the material was structured. The degrees of freedom available to the child was drastically reduced, compared with drawing.

The differences, found in our results, in the manner in which the 4-year-old group used symbols in drawing and play-constructions, can thus be explained by different task demands in these two representation modes. Similar findings have been obtained both by Golomb (1973, 1974, 1979) and Freeman (1977, 1980a, 1980b). They found that a well defined task (for example to complete an incomplete drawing) elicited a definite plan of action in the child and resulted in a more detailed and better organized representation than a task which was vague (as for example a spontaneous drawing).

A comparison of the two different conditions in play-constructions revealed that the visual accessibility to the play-material did not affect the representation structure in the older age group. In the younger age group, the play-condition where the subjects had to ask for toys, seemed to facilitate the representation process, resulting in a somewhat more coherent representation. It could be that the task demands in this condition focused the child's attention away from play and directed it to planful action. Planful action implies the subordination of imagination and fantasy (i.e. the primarily affective assimilations) to the demands of the task and medium. This is in line with Piaget's (1951) notion of the "work-like" quality of play-constructions, and also with Vygotsky's (1976) account on play. This is also in line with several others who argue that task demands may facilitate or complicate the performance of preschoolers (see Light, 1983 for a review).
These findings above suggest, therefore, that the same task instruction can place different demands on children, with the consequence that the representations which are produced will then vary in accordance with those demands. Some recent studies considering task instructions in drawing, have come to similar conclusions (Barrett, 1983; Barrett & Light, 1976; Cox, 1981; Freeman, 1980 a,b; Golomb, 1973).

On the whole, it seems that reasoning that receives support from the immediate external situation (for example experimental condition 3) imposes smaller demands than reasoning based on information that has to be represented internally (cf. Halford, 1989). Piaget recognized this kind of variation and termed it "décalage". However, Piaget's theory still does not offer good explanations for this kind of variation. The existence of this kind of variation continues therefore to raise troublesome questions (cf. Bidell & Fischer, 1989).

As was pointed out in the introduction of this study, to understand the subjects' representations it proved necessary to follow the whole representation process, including the subjects' comments. Considering only the end-products, i.e. the drawings and the play-constructions, there was hardly any coherence at all among the 4-year-old subjects' representations, which, moreover, comprised a mixture of correct and incorrect objects, i.e. objects not mentioned in the test-task. These objects were randomly drawn on the paper in drawing and placed all over the cardboard in play-constructions. Similar observations have been made by others (Freeman, 1976; Golomb, 1973, 1974; Goodnow, 1977; Kamp, 1947; Light & Simmons, 1983; van Wylick, 1936; Vygotsky, 1976).

Recently London (1982), who studied the children's spontaneous use of materials in painting and drawing media along with other materials, could show that social interaction and language played a great part of the
"working" atmosphere. It stimulated both the child's use of representation media and his performance in it. This is in line with our results, and with the discussion of the role of language carried on under the heading "Methodological considerations".

In summing up, it might be stated that the results of this study support the development trend of Piaget's theory, indicating that children's drawings and play-constructions develop according to general stages, postulated by Luquet and Piaget, and that this development is similar in both drawing and play-construction.

Whether these two representation modes are expressions of a single underlying semiotic function cannot reliably be concluded from the present results. One thing is sure, both the nature of representation media and the format of the task instructions play a considerable role in representations.

Piaget himself had paid too little attention to this. As far as it can be ascertained, he seemed to believe that the topics he investigated could be approached with equal vigour and accuracy. Our conclusion is, however, that there seems to be little question that considerable skill is needed to make sense of, and achieve fluency in different representation media. Nor can it be assumed that information can ever be captured and used in an exactly equivalent form across different representation modes (cf. Gardner, 1979; Salomon, 1978; Shotwell et al., 1980).

Clearly, a good deal of additional research is required to pinpoint the following questions: (1) Is there a common underlying semiotic function for representation? (2) How does this function develop in different representation mode and media? (3) How is this function influenced by
instructions and task demands? To investigate these important issues calls for careful studies both in the process (the operative aspect) and the product (the figurative aspect) of representation.
STUDY 2. Rules used by four- and six-year-old children to generate representations in drawing and play-construction

In study 1 we demonstrated that the child's ability to construct a spatially coherent representation in drawing and play-construction was a function of age. The representations in both modes developed according to general development stages, postulated by Piaget, and they were also similar in this respect across the two representation modes. Furthermore, we showed that the obtained differences in drawing and play-construction could be explained in terms of media problems and task-demands.

However, when we actually observed the 4-year-old children construct their representations, we were astonished about the manner by which they proceeded in their construction process. Despite that the end products of their representations (the figurative aspect) were spatially incoherent, we noticed that there was a distinct kind of logic inbedded in this construction process, invisible when only the end-products were obsevered. The 4-year-old children's representations contained quite a large number of task-irrelevant objects, especially in play-constructions. These objects were related to the correct ones by a manner which seemed to be worth a closer examination.

The questions that then arised were: (1) Are the young children's representations simply incoherent, i.e. the objects randomly brought together, or are they rule-governed? (2) If the representations are rule-governed, what kind of representation rules are used in this kind of process? (3) How do these representation rules develop with age?
Our observations and the questions that arose from them made us to introduce the distinction between figurative and operative knowledge. In terms of figurative and operative knowledge the questions above can be reformulated as follows: Are the children's representations in different representation modes (or in some of them) constructed mainly on figurative grounds, using perception, imitation and mental imagery as the basis for representation? Are the representations constructed also by operative knowledge, meaning that the children are using certain representation rules?

As mentioned before, operative knowledge involves more than an awareness of an object's perceptual qualities. It involves the understanding of what the object is used for, how it is constructed, how it affects other objects or events, and how it is influenced by them (Furth, 1969; Sorce, 1980). Consequently, operative knowledge is rule-bound knowledge, it is the code through which the child transforms a given situation into something he understands. As such, it is a function of the child's development stage, i.e. of the child's general operative understanding. By contrast, figurative knowledge is content bound and static, meaning that the child can construct symbolic representations without corresponding understanding of the situation.

In order to study the questions above we decided to reanalyse the data from study 1, now focusing on the operative aspect of representation. A general purpose of the present study was to explore the kind of representation rules the pre-operational children use. We were also interested whether the rules used in representations in drawing and play-construction would be of the same kind, thereby supporting Piaget's notion of a single underlying semiotic function for representation.
Since the same data as in study 1 were analysed, we pass over the part of method which (being the same in both cases) is described in study 1.

Considering previous findings in this area it could be found that before the age of four, the child cannot yet make any use of representation rules, if he has such rules (Piaget & Inhelder, 1964; Vygotsky, 1962). During the first stage the child's criteria for adding objects to each other is continually changing. In some instances the child relates objects according to some similarity which the objects share, it could be the form or the color. Then he can suddenly change his criterion and relate objects according to some shared interrelationship between them, such as a baby and a crib. Then he can return again to the former, similarity based criterion. The rules, if there are any, do constantly alternate.

During the pre-operational stage, i.e. between the ages four and seven, the rules children use to construct representations are not yet formal but stem from the child's daily experience, reflecting the model of logic the child possesses. The inferences that the pre-operational child makes are empirical, meaning that they are taken from direct experience (Annett, 1959; Aronsson, 1978; Cole & Scribner, 1974; Dasen, 1972; Freeman, 1972; Gardner, 1982a; Greenfield & Bruner, 1966; Kagan et al., 1963; Markman, 1979; Olver & Rigney Hornsby, 1966; Piaget & Inhelder, 1964; Vygotsky, 1962; Werner, 1948).

According to Piaget (Piaget & Inhelder, 1964) empirical rules of representation permit the use of two different strategies: belonging and similarity. 'Belonging' means that objects are related on basis of what Piaget calls 'partitive membership', i.e. one element is a representative part of the whole. 'Similarity', on the other hand, means that the objects are related on basis of 'class membership'. Since empirical rules of representation
are rooted in practical experience the representations they generate may be distorted, from the formal point of view, and expressed in the form of 'complexes' (see, for example, Vygotsky, 1962). This means that the children may incorporate task-irrelevant objects into their representations, suggesting that there is a relationship between the child's cognitive functioning (reflected by the representation rules) and subsequent use of symbols.

After the age of seven, the child is able to construct spatially coherent representations without distorting the verbally given information. The representation rules may now be regarded as formal, i.e. the representations would be constructed in such a way that there will exist a formal correspondence between the verbal concepts and the representative objects (Aronsson, 1978; Piaget & Inhelder, 1964, 1969; Vygotsky, 1962).

Assumptions for this study
If different forms of representations are determined by a single underlying semiotic function, we would expect that children's drawings and play-constructions would be constructed in a similar way, i.e. we should expect to find the same kind of rules in both these representation modes. Further, we would expect to find a similar development of the representation rules in both representation modes, that is, a development from empirical to formal rules. Thus, the 4-year-old children are supposed to use empirical rules and the 6-years-old children are supposed to use formal representation rules in both representation modes. The purpose of the present study was investigate this issue.

The specific hypothesis for the study may be summarized as follows:

Children will use the same kind of representation rules in drawing and in play-constructions, irrespective of whether these rules are empirical or formal rules. Thus, if children use empirical representation rules in drawing,
they should also use empirical rules in play-construction, and if they use formal rules in drawing they should use formal rules in play-construction also.

The 4-year-old children are supposed to use empirical representation rules, thereby distorting the verbally given information, and draw and/or arrange the objects into 'complexes'. The 6-year-old children, on the other hand, are expected to use formal representation rules and construct reasonably correct representations of the test-task.

**Dependent variable**

For each age group and experimental condition the number of different strategies - 'belonging' and 'similarity' - was calculated as described below in order to analyse the character of the representation rules. Only objects that were incorrect with respect to the task were analysed according to the strategies 'belonging' and 'similarity'. Thus, these objects indicate the use of empirical representation rules.

Since Piaget's own approach was clinical-descriptive and based on qualitative data, we took into consideration even the subjects' verbal protocols in the different experimental conditions. Thus, the subjects reasoning, when incorporating task-irrelevant object into representations, served as an additional indicator of the strategies used.

**Scoring procedure for strategies.** A strategy was classified as 'belonging' if the relation between two different, task irrelevant objects was determined by a functional bond with an empirical meaning. For example, when a child drew two task irrelevant objects (a doll and a baby doll) in experimental condition 1, when he asked for a task irrelevant toy (experimental condition 2) or when he chose such a toy (experimental condition 3), and explained that the objects he drew, asked for or chose belonged together.
A strategy was classified as 'similarity' if the relation between objects was determined by the superordinate class into which the objects belong. For example, when the subject related different animals and/or humans to each other without specifying their mutual relationship, i.e. saying "I want another tiger, tree, doll etc., the strategy was classified as 'similarity'.

The material which formed the basis for further analysis of the children's drawings (experimental condition 1) comprised the subjects' drawings, the list of drawn objects, and the subjects' protocols. For the two other experimental conditions in which the subjects built a representation by asking for toys (experimental condition 2) or by choosing toys (experimental condition 3), the photographs of the end-products together with the subjects' protocols were used as the basis for analysis.

For each age group and experimental condition two independent raters made the classifications for the number of different strategies used. The mean interrater reliability determined by Pearson r coefficient between the author's classifications and those of the other rater was $r = .94$.

**RESULTS AND DISCUSSION**

**Strategies used in constructing representations**

The means and standard deviations for 'belonging' and 'similarity' and for unspecified strategies in representations in the different age groups are given in Table 1.

As can be seen from Table 1 the strategy 'belonging' dominates in all experimental conditions and in both age groups. It is more frequent among the 4-year-old children and greater in play-constructions than in drawing. The
strategy 'similarity' is about equally frequent in both age groups and somewhat more frequent in the third experimental condition - building by choosing toys - than in the other experimental conditions.

Table 1. The means and standard deviations for strategy 'belonging' and 'similarity' and for unspecified strategies in drawing, building by asking for toys and building by choosing toys in both age groups.

<table>
<thead>
<tr>
<th>Age / Strategy</th>
<th>Drawing</th>
<th>Building by asking for toys</th>
<th>Building by choosing toys</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belonging</td>
<td>M 4.67</td>
<td>10.44</td>
<td>17.55</td>
</tr>
<tr>
<td></td>
<td>s 11.40</td>
<td>17.84</td>
<td>34.21</td>
</tr>
<tr>
<td>Similarity</td>
<td>M 0.89</td>
<td>1.22</td>
<td>2.44</td>
</tr>
<tr>
<td></td>
<td>s 2.62</td>
<td>3.68</td>
<td>5.68</td>
</tr>
<tr>
<td></td>
<td>M 0.67</td>
<td>0.10</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>s 3.74</td>
<td>0.95</td>
<td>1.41</td>
</tr>
<tr>
<td>Unspecified</td>
<td>M 1.36</td>
<td>0.89</td>
<td>2.33</td>
</tr>
<tr>
<td></td>
<td>s 2.81</td>
<td>3.30</td>
<td>6.63</td>
</tr>
<tr>
<td></td>
<td>M 0.11</td>
<td>0.44</td>
<td>1.44</td>
</tr>
<tr>
<td></td>
<td>s 0.95</td>
<td>2.87</td>
<td>7.63</td>
</tr>
<tr>
<td>6-year-old</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belonging</td>
<td>M  -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>s -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Similarity</td>
<td>M -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>s -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>M -</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>s -</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

A two way (Subjects x Representation mode) Friedman analysis of variance by ranks for the number of strategy 'belonging' yielded a significant effect of Representation
mode $X^2_r = 11.19\ (k=3,\ N=9),\ p < .001$. For the 6-year-old group there were no significant differences among representation modes.

A posteriori comparison using the Sign test showed that there was a significant effect both between drawing and between building by asking for toys ($x=0;\ N=9$), $p = .002$, and building by asking for toys and building by choosing toys ($x=3;\ N=9$), $p = .254$.

A two way (Subjects x Representation mode) Friedmans analysis of variance by ranks for the number of strategy 'similarity' yielded a significant effect of Representation mode $X^2_r = 6.73,\ p < .05$ for the 4-year-old group. For the 6-year-old group there were no significant differences among representation modes.

A posteriori comparison using the Sign test showed that the significant effect was only between the experimental condition 2 and 3 (building by asking for toys and building by choosing toys). The difference between drawing and choosing by asking for toys was not significant.

The analysis shows that the representation mode had a significant effect on the number of strategies 'belonging' used by the 4-year-old group, and partially also on the strategy 'similarity'. This indicates that there are special media effects at work in the younger age group.

As far as the age effect is concerned it can be seen from the Table that the number of strategy 'belonging' is considerably greater in the 4-year-old group.

**Degree of consistency in using strategies**

To determine the degree of consistency in the subjects' strategies, the number of subjects who used either the strategy 'belonging' or 'similarity' as the main strategy through all three experimental conditions was calculated for each age group.
The results showed that there is a very high degree of consistency in the subjects' use of strategies in both age groups. Eight of the nine 4-year-old subjects used the strategy 'belonging' as their main strategy in all three experimental conditions. The remaining subject used the strategy 'belonging' in two of the three experimental conditions. In the 6-year-old group only seven out of nine subjects used incorrect objects in their representations, and consequently we have data for two different strategies only for them. All of these seven 6-year-old subjects used the strategies consistently, i.e. they used either 'belonging' or 'similarity' as their main strategy through the three consecutive experimental conditions.

**Number of correct objects in representations**

To determine how well the subjects remembered the test-task when constructing their representations in different experimental conditions the number of correct objects used was calculated for each age group. The results are given in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Drawing</th>
<th>Building by asking for toys</th>
<th>Building by choosing toys</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td>14</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>6-year-old</td>
<td>22</td>
<td>23</td>
<td>22</td>
</tr>
</tbody>
</table>

Total number objects in the test-task: N = 24

As can be seen from Table 2 the subjects in both age groups used about as many correct objects in all three experimental conditions. In the 4-year-old group the omitted objects were mainly peripheral in relation to the main
themes in the test-task. These findings suggest therefore that the subjects in both age groups remembered the test-task equally well, regardless of whether they had to draw or to use toys in their representations. However, the older age group used considerably more correct objects in their representations compared with the younger one.

Retelling the test-task
In analysing the errors it could be noticed that the subjects of both age groups added task irrelevant information and elaborated the test-task narrative already in retellings. In the 4-year-old group the irrelevant information was related directly to the objects in the test-task story by the strategy 'belonging'. In the 6-year-old group the subjects elaborated the test-task both by simple 'belonging' strategies, i.e. things belonging together empirically, and by inferences about the objects, actions and goals inbedded in the story.

For example 4-year-old subjects could state as follows: "There was a crocodile (task relevant information) and he had very sharp teeth, and dangerous eyes, and he could bite (the last part of the sentence being task irrelevant combined to the rest by 'belonging')."

In the 6-year-old group subjects elaborated as follows: "The prince and the princess went down to the sea and entered the boat (so far the information is correct), and alas, the boat could float without any wind, it must have been enchanted (elaboration by inferences). And down in the sea there was a crocodile (correct information) who was asleep because he was so tired, and if you wake him up he will be unhappy (elaboration by both 'belonging' and inference).

Attitudes toward the task
Considering drawings children frequently criticized their own work and this tendency increased with increased age. In the younger age group the children complained that the
different objects in their drawings did not look like the objects named in the test-task narrative. As a consequence of this they could rename some of the finished products or create a bond (usually by an empirical strategy) between the drawn objects. They did not, however, attempt to modify their drawings. In the older age group the critical attitude was accentuated, but now it did no longer interfere with the finished product.

Considering play-constructions the state of affairs was the other way round. The children in the younger age group were very fond of their play-constructions, and specially of those aspects of the constructions which were not in accordance with the test-task, but invented by the children themselves. So the children tended, for example, to furnish the test-task cottage by putting the furniture outside the house. When asked if the furniture was really outside the cottage the answer was: "No, but you have to put it there because you cannot get inside the toy."

Since the 4-year-old children used so many incorrect objects in their representations it could be suspected that the children did not really understand the test-task (compare the spatially incoherent retellings and the discussion considering the subjects comprehension in Study 1). Nevertheless (as was discussed earlier), even in the present case, following the children's spontaneous comments, it was obvious that they could make a difference between the correctly presented test-task and the one they were constructing.

In the older age group the same tendency could be seen, i.e. the subjects attempted to elaborate the test-task, but now the elaboration took place mainly on a verbal plane. The children could complain, for example, over the test-task narrative, considering it to be too poor in details or too odd in relation to reality. For example one six-year-old boy said: "It would be nice if you had a park with trees and benches near the circus so people could sit and
watch the show, you know it usually is like this, but since your story did not say anything about it I leave it this way."

**Continuous comments about the task**

In constructing representations in all three experimental conditions and in both age groups there was a running commentary that accompanied the task.

Considering drawing (experimental condition 1) in the younger age group, this commentary was notably more detailed than the graphic representation itself. A child could, for example, describe in detail the kind of objects he was going to draw, including incorrect objects related to the correct ones by strategy 'belonging', and yet end up with a simple drawing of mainly correct objects. It seemed as if the act of drawing was so tiresome on the part of the young child that the creation of graphic representation became rather scanty, leaving the verbally expressed empirical strategies behind on the verbal plane. A slightly similar tendency was found in the 6-year-old group.

In play-constructions the children were playing with the toys, moving them around, before they decided to put them into their proper place. In the 4-year-old group the distortions were commented by statements like: "I know your story, but you know they have to eat, sleep, have babies, etc., that's why the things belong there." The 6-year-old children, on the other hand made few distortions, and in so doing they were very much aware of their distortions.

**CONCLUDING DISCUSSION**

The results of this study showed that the representation rules used by the two age groups are similar in the two representation modes compared, i. e. in drawing and in play-constructions. This means that, regardless of whether the children construct their representations by empirical
or formal representation rules, they construct them in a similar fashion in both representation modes. Thus, when they relate task-incorrect objects to representations they reason the same way and use the same strategies in all representation modes. However, the number of strategies used in different experimental conditions, i.e. the number of incorrect objects added, varied as a function of representation media.

The results, so far, are therefore not entirely in agreement with the main hypothesis of the study, proposing that the operative aspect of representation (i.e. the rules used to construct representation) will be the same in both representation modes. It is true that the subjects used the same kind of representation rules in both representation media, but the number of rules used differed in the two representation modes. Hence, the present findings are not in accordance with Piaget's hypothesis of a single underlying semiotic function for representation, but indicate that there are special media effects at work.

Furthermore the results showed that the 4-year-old subjects used mainly empirical rules of representation, thereby distorting the test-task information by adding incorrect objects to it, and ending up with what Vygotsky (1962) called 'complexes'. The 6-year-old subjects used mainly formal rules for representation and represented the test-task in a way that corresponded with the verbally described test-task. Still, the thinking of the 6-year-old children is in a transition phase, somewhere in between the empirical and formal mode. Therefore, when the subjects' real-life thinking contradicted the formal rules of the test-task, the formal rules were abandoned and the empirical representation rules were adopted. For example, when the subjects knew that in real life there are additional objects in such a scene they could add some of them to their representation. These findings are in accordance with Piaget's theory.
With regard to the figurative aspect, i.e. the content of the representations, the results showed that the 4-year-old subjects produced about as many correct objects in all three experimental conditions, suggesting that they remembered the test-task equally well, regardless of whether they had to draw or to use toys in their representations. However, when they were provided with actual toys to ask for or to choose from, the number of incorrect objects increased dramatically. This also suggests that there are special media effects at work.

Findings indicating media effects, have been obtained by several investigators (Dillström Norgren, 1985; Golomb, 1973, 1974; Olson, 1970; Oppenheimer & Strauss, 1975; Shotwell et al., 1980). Golomb (1973), who used different media when investigating young childrens ability to construct representations, could notice that, when children were given ready made forms for representation, their performance on these tasks was superior to their drawings. Her conclusion was that there is a subtle interaction at work between the children's knowledge about representation and the actual steps they must take to express this knowledge in different media. Accordingly, she offered a hypothesis, stating that the child's cognitive development follows the stages described by Piaget, yet the developmental level of a child interacts also with the experience and demands of each medium. We agree with her position. Similar points of view are also held by several other reseachers (Barrett, 1984; Cox, 1981; Franklin, 1973; Freeman, 1977, 1980a,b; Golomb, 1973, 1974; Goodnow, 1971; Oppenheimer & Strauss, 1975; Shotwell et al., 1980).

In the present results the number of incorrect objects in the 4-year-olds' representations was significantly greater in play-constructions than in drawing and greater when the child had free access to the toys compared to the condition when he had to ask for them. This indicates that, when the child has to construct his representations with "real"
objects (toys), and when the task demands are minimal (free access to the toys), the child will be more likely to utilize his operative knowledge, compared with cases where the task and media demands are harder.

Therefore, in drawing where the child has to invent his own symbolic forms he might focus more on observable details of the drawn objects (the figurative aspect), and miss partially the operative aspect of the problem. This would explain why the number of representation rules was smaller in drawing than in play-constructions, and smaller in the condition where the child had to ask for the objects, compared with the condition where he could choose them freely.

This is in line with Sorce (1980) who studied preschool children's responses to real objects and their pictorial representations and analyzed the results in terms of figurative and operative knowledge. He could show that children had a greater tendency to produce operatively based responses with real objects and figuratively based responses with pictures. These findings indicate that, the acquisition of representation is interacting with the symbolic media.

Similar media effects as in 4-year-old subjects, could be observed also in the 6-year-old subjects' representations, even if these subjects generally constructed correct representations, using formal representation rules. In play-constructions, for example, where there was free access to the play-material, the 6-year-old's also added incorrect objects to their representations more frequently than they did in other experimental conditions.

The above suggests that different representation media offer different degrees of resistance. However, even if the representation media has certain effects on the content of the representation, namely on the number of empirical strategies used, the representations themselves are,
nevertheless, constructed in a similar manner, regardless if it is in drawing or in play-constructions. This indicates that the operative aspect of representation is fairly uninfluenced of the representational content. Furthermore, to be able to use operative knowledge in a significant way seems to require higher level of familiarity with the representation medium (cf. Kelly et al., 1984).

The present findings, concerning the operative aspects of representation, therefore support Piaget's idea of a single underlying semiotic function, as far as this aspect is concerned. However, the findings also point to the complexity of the problem of experimentally studying the parallel development of representation in different representation modes.

In the two representation modes investigated - drawing and play-construction - the point of departure differs between the two modes. In drawing the child has first to construct the symbols, and thereafter to organize them in a formally correct representation. Thus, the main effort on the part of the subject is to construct the "vocabulary" needed for the representation, and then as a second step to organize this "vocabulary" according to formal rules. The creation process itself is tiresome, and in most cases poorly practiced by the children. The need to produce a concrete representation in the form of a drawing seems, then, merely to compound the overall difficulty of the task.

In play-construction, on the other hand, the child is presented with ready-made representative symbols, and he can minimize his concentration on the visual configurations (the figurative aspect) in favor of an active, transforming, or operative approach to the test-task. Thus, the first step of representation, i.e. the construction of symbolic forms, is not present in this representation mode. Furthermore, the effort to construct a representation in this mode is considerably reduced, and the children have,
presumably, a lot of more practice in this representation media. Playing with toys is a kind of activity in which children in our culture are engaged from a very early age, thus acquiring earlier the skills and competence in this mode of symbolic behavior. The two representation modes are, therefore, not equivalent at the outset, requiring different skills on the part of the subject.

Studying experimentally the parallel development of representation in different representation modes could therefore be difficult when cross-sectional data are used. By their nature, cross-sectional data cannot identify temporal sequences in different representation modes (cf. Smolak & Levine, 1984). For example, the development of symbolization in drawing may not have achieved the same level, at the same chronological age as the corresponding development in play-construction. This can be so because of maturational factors (children's motoric ability with different materials, for example in drawing), or it may be so because of cultural factors (our culture does favor children's play activities more than their drawing ability). Even individual differences in representation ability can be of importance.

Piaget himself has paid too little attention to these factors. He is, for example, quite indifferent to individual differences, and minimizes cultural and social factors in the child's mental development. Piaget's theory of universal cognitive structures implied a relatively tight temporal synchrony for the acquisition of a given cognitive skill across individuals and situations, making variation hard to explain. In order to explain the obtained differences in children's ability with different tasks Piaget introduced the term décalage, meaning that there is a time lag in the appearance of related cognitive processes (vertical décalage), and a time lag between the abilities to use different materials or tasks (horizontal décalage). This explanation is in our opinion too global, and does not take into account the specific factors in each
representation media and task. The existence of these variations remains, causing annoying questions and difficulties for Piaget's theory (cf. Bidell & Fischer, 1989).

When cross-sectional data nevertheless are used, the test-tasks should be made more or less comparable. This can be done in several ways: For example, in drawing the child could, in the present case, have been presented with ready made drawn forms, thereby making the drawing task more equal to the one in play-construction. Golomb's (1973, 1974) research gives some evidence supportive of this proposal. Comparing the children's ability to construct the human figure out of ready-made parts (a puzzle) to their ability to draw it spontaneously, Golomb could show that far greater knowledge is available to the child in case where ready-made parts were used. Nevertheless, the following questions remain to be answered. In what way differ the ready-made drawn parts from the objects in play-construction? Can ready-made drawn parts be considered equivalent to children's drawing? How much can a task be altered before it becomes another task, assessing a different skill or a different level of skill? Similar problems about different media and task-simplifications have been observed and discussed by others (Bidell & Fischer, 1989; Freeman, 1977, 1980a,b; Oppenheimer & Strauss, 1975; Robinson & Robinson, 1983; Shotwell et al., 1980; Smith, 1979; Smolak & Levine, 1984; Sorce, 1980).

Another way to make the test-tasks more comparable is to give the young children opportunities to practice drawing until they are mastering the representation media with about the same ease as play-construction. The questions that then arise are: Is this a feasible strategy considering the 4-year-old children's motoric difficulties with the representation media in question? How much external support is the "right" amount before we lose the "real" skill in this particular media?
According to these perspectives, it should be pointed out that there may be no way in which absolutely equivalent tasks in two media could be presented, because each medium, representation mode or material favors, by its very nature, certain representative symbols (and their use), at the expense of others. Such a state of affairs pose surely a difficulty for Piaget's theory, but it does in no way lessen the interesting results which could emerge, when attempts are made to compare representations across media. However, there remains many both theoretical and methodological problems to be wrestled with.
STUDY 3. Relations between imitation and drawing in four- and six-year-old children

In study 1 and 2 we were able to show that the children's representations in drawing and symbolic play were similar, in a global sense, both with regard to the representation structure (the figurative aspect) and with regard to the representation rules (the operative aspect). However, the representation media played a certain and not unimportant role which should not be neglected. Graphic representation, i.e. drawing, proved to be more demanding than play-construction, calling in question a strictly Piagetian "semiotic approach", proposing that different representation modes of the semiotic function can be investigated in a strictly parallel fashion.

Despite these problems, which were not obvious at the time being, we proceeded our studies by investigating an additional representation mode - gestural imitation - and compared it with drawing. According to Piaget (Piaget, 1951; Piaget & Inhelder, 1969) imitation (i.e. deferred imitation) is closer to drawing than to symbolic play, the two former being expressions of accommodation. Play is, as we know, characterized mainly by assimilation. This closeness between imitation and drawing led us to assume that there exists a greater similarity between these two representation modes than between drawing and play.

The purpose of the present study was to investigate the relation between imitation and drawing, from the figurative point of view. In so doing, we chose to examine the degree of integration in the representation structure in the two representation modes. If imitation and drawing are both manifestations of the same semiotic function, the representation structure in both representation modes should be similar.
Since the test-task used in study 1 and 2 was both too long and too unstructured, we chose a test-task which was both shorter and more well-structured. This was done with the aim to make the task easier to represent and to give the child less freedom to make deviations from the test-task. As discussed earlier, a well-structured test-task is assumed to direct the child's attention to planful action, preferable in the present case.

Research regarding the development of gesture has been relatively parsimonious, although the importance of gesture as an early form of symbolization is well recognized (Piaget, 1951; Werner & Kaplan, 1963). Reviewing literature we found relatively few studies, and these, in turn, have generally included only a small number of children (Bates et al, 1975; Blurton-Jones, 1971; Kaplan, 1968; Klapper & Birch, 1969; Lock, 1978; Michael & Willis, 1968; Overton & Jackson, 1973).

**Gestural imitation.** In imitation the child uses his body, or parts of the body, for representational purposes. The signifiers used for representation are "representational gestures". There are two general types of representational gestures: (1) Depictive gestures, involving the use of the whole body or parts of the body to depict, i.e. to represent, specific properties of objects, persons or events. (2) Enactive gestures, involving the reenactment of an everyday goal-directed action sequence in a representational context, as in a game of eating, where real-life motions of drinking, using knife and fork in cutting the food, etc. are carried out in the absence of any external props (Franklin, 1973).

These two types of representational gestures can also occur together, as when the child cups his hand to depict the form of a cup and moves his arm towards his mouth in reenacting the motions used when actually drinking.
The development of depictive gestures has been studied by Piaget (1951) and Werner and Kaplan (1963). Depictive gestures come closest - of all the forms of gesture - to being a visual medium external to the symbolizer. Piaget saw depictive gestures as the earliest type of symbolization, and he believed that they derive from the child's direct imitation of movements.

The development of enactive gestures has been studied by Barten (1979), El'Konin (1971), Franklin (1970), Kaplan (1968), Klapper and Birch (1969), Marti (1984), Overton and Jackson (1971), and Stern (1973). Enactive gestures are movements that represent actions upon objects or actions performed with objects, for example to comb one's hair, to feed one's doll, and so on. These studies show that younger children tend to use a body part to represent the object, whereas older children are able to perform actions upon and with totally imaginary objects.

To summarize the findings above, they indicate that depictive and enactive gestures develop in a parallel fashion. Both types of gestures develop from a diffuse global state, through a state of differentiated but unrelated parts, to a state in which the parts are integrated into a whole. Moreover, the symbolic character of the representational gestures decreases with increasing age and the symbolic gestures are replaced by more realistic looking copies of reality.

The differentiation process progresses along three lines: (1) Differentiation among the signifiers, i.e. among the components of the child's activity (2) Differentiation of activity from the self, i.e. from using body-parts as implement to more purely enactive gesture, and (3) Differentiation of the self from activity, i.e. from self oriented activities to general representation of activities.
Between the ages of two and four the children's spontaneous imitation is of a very general and global character. At these ages the children cannot imitate on request. The activities that the children enact are gradually differentiated. At an age of two years, the child can feed a doll with a "functional substitute" (e.g. orange rind for cup). At three to four years the child is able to use "symbolic substitutes" for the whole activity (e.g. stick for doll, disk for cup) (Elder & Pederson, 1978; El'Konin, 1971; Piaget, 1951).

Between the ages of four and seven, the representative gestures become more differentiated but still the children do not attempt to imitate the details of a model to any great extent. Now the child is able to use enactive gestures in the absence of any object, i.e. with an imaginary object, and his ability to carry out "appropriate pantomimic activities" is steadily increasing, thus indicating a differentiation among the signifiers (Kaplan, 1968; Klapper & Birch, 1969; Marti, 1984; Piaget, 1951; Werner & Kaplan, 1963).

Between the ages of four and seven, there is also progressive differentiation of activities from the self. Thus, one can note a clear shift in the children's representative gestures from using symbolic objects of a body-part as a signifier (e.g. using a symbolic substitute of a hand as a hammer) to more pure enactive gestures (positioning the hand as if holding the hammer and enacting hammering motions) (Kaplan, 1968).

But although the children's gesture patterns now consist of differentiated parts the children are still not able to combine these patterns into unified wholes (Piaget, 1951). In this respect imitation can be compared to drawing at the same age level, which is syncretic and rigid in character. In his drawings, the child is incapable of synthesizing the
parts into an integrated whole (Luquet, 1913, 1927; Piaget, 1951).

Furthermore, there is a differentiation of self from activity. Thus, the children's enactive gestures develop earlier with respect to self-directed activities (e.g. hammering the nail) (Overton & Jackson, 1971), and earlier in relation to "in-door" situations than to "out-door" situations, i.e. situations at greater distance from the self (Franklin, 1971; Stern, 1973).

After the age of seven, the three differentiations are fully developed. Now the children can carry out purely enactive activities in absence of objects and their representations take form of fully elaborated pantomimic acts. At this age, the children also show considerably greater interest in imitating details of the model. Their representative gestures are now imitative copies of the model and not purely symbolic substitutes as was the case earlier.

Furthermore, the children are able to analyse and reconstitute a model by integrating it's parts into an integrated whole. The situations that the children are able to represent at this age can be at any distance from the self (Franklin, 1970; Kaplan, 1968; Overton & Jackson, 1971; Piaget, 1951; Stern, 1973; Werner & Kaplan, 1963).

**Drawing.** The development of drawing is similar to that of imitation. The child's very first representative drawings most frequently consist of global, undifferentiated forms and shapes, chiefly marking the over-all qualities of the drawn objects. The younger the child is, the more incoherent his drawings (Barrett, 1983; Freeman, 1972, 1976, 1980a,b; Golomb, 1973, 1974; Goodnow, 1977, 1978; Goodnow et al., 1986; Kellog, 1969; Leeds et al., 1983; Luquet, 1913, 1927; Monoud, 1971; Oliver, 1974; Smith, 1972, 1979).
Before the age of four children seem to be quite insensitive to how different parts of a picture should be related, and they do not seem to realize the importance of drawing all the objects which make up the integral parts of the picture.

Between the ages of four and seven, the children's drawings become more detailed and complex. But although the children differentiate between the signifiers (the representative symbols that make up parts of the drawing) considerably more than at the earlier age, they still can not coordinate them into an integrated whole. Thus, their drawings express a lack of synthetic capacity, i.e. the elements of the drawing are juxtaposed instead of being coordinated into a whole (Luquet, 1913, 1927). The symbolic character of the drawn objects decreases gradually during these ages and is replaced by more realistic looking copies of reality (Freeman, 1972, 1976, 1980a,b; Golomb, 1973, 1974; Goodnow, 1977, 1978; Goodnow et al., 1986; Kellog, 1969; Leeds, 1983; Luquet, 1913, 1927; Monoud, 1971; Oliver, 1974).

After the age of seven, the children's drawings have become detailed, complex and coherent. The signifiers, i.e. the drawn objects, are straight-forward imitations of their real-world counterparts and the relations between the objects are topographically adjusted. Still the children's drawings lack visual perspective, which develops at the age of about nine (Freeman, 1972, 1976, 1980; Golomb, 1973, 1974; Goodnow, 1977, 1978; Kellog, 1969; Leeds et al., 1983; Luquet, 1913, 1927; Monoud, 1971; Morss, 1987; Oliver, 1974; Young, 1984).

The results described above suggest that the development of children's representation as expressed in imitation is related to that expressed in drawing. Piaget (Piaget & Inhelder, 1969) himself stressed the correspondence between children's deferred imitation and Luquet's (1927) development-sequence for drawing. This is also what Piaget's hypothesis of a single underlying semiotic
function for representation would lead us to expect. There has, however, not been any direct comparison of drawing and gestural imitation, considered as the manifestations of the semiotic function.

The purpose of the present study, therefore, is to investigate the relation between deferred imitation (representational gesture) and drawing (graphic representation) with the same children and the same test-task, thus enabling us to investigate whether these two manifestations of the semiotic function are related as Piaget's theory predicts.

The age groups in the study comprise four- and six-year-old children. Pilot work revealed that children below the age of four could not imitate or draw on request. Nor could the 4-year-old children imitate activities that were unfamiliar to them, i.e. activities they had not acted themselves in their everyday life. Children above the age of six were too advanced for the problem in question.

METHOD

Subjects
Eighteen middle class children from a nursery school in Boden, a small town situated in the north of Sweden, served as subjects. Nine children (9 boys) with a median age of 4.0 years (3.6 - 4.9) were assigned to the 4-year-old group, another 9 children (4 boys and 5 girls) with a median age of 6.4 (5.10 - 6.11) to the 6-year-old group.

Test-task
Three action sequences identical to real-life activities, oriented against the self and familiar to the subjects served as a test-task.
The sequences were as follows:

1. To put on a jacket, a cap and boots.
2. To eat with knife and fork and to drink milk from a glass.
3. To wash with soap and water and dry with a towel.

Material
Sketch-pad paper and pencils were provided for drawing.

Design
A mixed factorial design (experimental condition x age x action sequences) was used with the action sequences (=test-task) as a within subject factor. The order of the three action sequences was counterbalanced according to a latin-square-arrangement. Five of the subjects in each age group were given the imitation-test first and then the drawing-test. The order was reversed for the other four subjects in each age group. The experimental conditions in imitation and drawing were as follows:

1. **Representational imitation.** The subject had to enact the action sequences, described by the test-task.

2. **Drawing.** The subject had to make a drawing of the action sequences, described by the test-task, using the pencils and the sketch-pad paper.

Procedure
The subjects were tested individually. The test sessions took place on two consecutive days. One experimental condition of three test-task sequences was given on each day. During the testing, the experimenter and the subject were alone in a room adjacent to the common nursery hall. The test-task sequences were presented verbally, one at the time. For each test-task sequence, the subject was required to tell the experimenter what he was going to do. The instructions for representative imitation were: "I want you
to show me, pretending you are performing an act without any equipment how it looks when you ..... (sequence one) put on your jacket, cap and boots to go out-doors. The instruction for drawing was: "I want you to make a picture of how it looks when you ..... (sequence 1, 2, 3).

Directly after retelling the test-task sequence, the subject was required to perform the imitation or the drawing. The three test-task sequences were performed one after the other on the same occasion. The experimenter encouraged the subject to comment on the different steps taken in imitation and in drawing. The subject's imitative acting during the different test sequences was described and recorded on tape by the experimenter. A transcript of every tape-recording was typed the same day. The transcript served as documentation of each subject's performance in the imitation condition. In the drawing condition the subject's drawings served as documentation of his/her performance. The order in which the different objects were drawn was recorded on each drawing.

Dependent Variables
For each subject and experimental condition, the degree of integration in representation was obtained as described below in order to provide an overall measure of the aspect of integration.

Scoring procedure for the degree of integration.
Every action-sequence included several task-relevant actions with corresponding relevant objects. These were as follows:

Sequence 1: To take on 1. jacket, 2. cap and 3. boots.
Sequence 2: To eat (plate with food, cutlery)
2. To drink (glass).
Sequence 3: 1. To wash (water, soap) 2. To dry (towel).

To be classified as a completely integrated action sequence, all the relevant actions in imitation and the
corresponding objects in drawing had to be present. Further, there had to be a temporal contiguity between the different relevant actions in the subject's action sequence in imitation and a spatial contiguity between the drawn objects, i.e. the drawn objects had to be related to each other topographically. When there was no continuity in an action sequence, i.e. when the sequence was represented as two of three temporally isolated activities in imitation, or as spatially isolated objects in drawing, the representation was classified as 50% integrated.

For every missing relevant action in imitation or object in drawing, an additional 25% was subtracted from the integration score. Thus, a representation in which continuity and one relevant action or object was missing was classified as 25% integrated, continuity and two relevant actions or objects missing 0% integration.

The degree of integration in representations was defined in terms of the following hierarchical classes:

- 100% integration - totally integrated representation
- 75% integration - one relevant action or object missing
- 50% integration - continuity missing
- 25% integration - continuity and one relevant action or object missing
- 0% integration - continuity and two relevant actions or objects missing

**Number of details in representation**

For each age group and experimental condition the number of part-actions in imitation and objects in drawing was calculated in order to provide a measure from the aspect of details in representations.

Two independent raters made the classifications and scorings for two subjects in each age group, both with
regard to the degree of integration and to the number of
details in representations. The interrater agreement was
100%.

RESULTS

Degree of integration in representations
The number of representations attaining different degrees
of integration in imitation and drawing in each age group
are given in Table 1.

Table 1. Number of representations in each age group
attaining different degrees of integration
in imitation and in drawing.

<table>
<thead>
<tr>
<th>Age-group</th>
<th>4-year-old</th>
<th>6-year-old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental condition</td>
<td>Imitation</td>
<td>Drawing</td>
</tr>
<tr>
<td>Degree of integration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 %</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>75%</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>50%</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>25%</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of representations = 27

As can be seen from this table 6-year-old children, show
the same degree of integration in both imitation and
drawing. On the average, this is true also for the 4-year-
old children, although their representations in drawing
show more variability than those in imitation. It can also
be seen that the average degree of integration is much
higher in the 6-year-old children than in the 4-year-old
children. The "ceiling" effect in the 6-year-old group
indicates that the test-task might have been too easy for
this age group.
Degree of similarity in representation modes
In order to see whether the degree of integration is similar in imitation and drawing, the number of subjects in each age group attaining the same degree of spatial coherence all experimental conditions was calculated. The results showed that all subjects in the 6-year-old group attain the same degree of spatial coherence in both representation modes and all experimental conditions, whereas in the 4-year-old group about 70 procent, i.e. 6 subjects fulfil this criterion.

Degree of consistency
To see whether the degree of integration is consistent through all experimental conditions, the number of subjects in each age group attaining the same degree of integration in all three experimental conditions and in both representation modes was calculated. The data are given in Table 2.

Table 2. Number of subjects in each age group attaining the same degree of integration in all imitations and in all drawings.

<table>
<thead>
<tr>
<th>Age-group</th>
<th>Imitations</th>
<th>Drawings</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>6-year-old</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

As can be seen from Table 2 the subjects exhibit a very high degree of consistency. All of the subjects in the 6-year-old group attain the same degree of integration in all imitations and drawings (as can also be concluded from Table 1) and eight subjects in the 4-year-old group do so.

Number of actions
The mean number of actions in imitation for the 4-year-old group was lower than that for the 6-year-old group, M =
9.56 and $M = 41.67$ respectively. The $t$-test for differences between the means was significant, $t = 7.01$, $p < 0.05$, $df = 16$.

**Number of objects**

To make the data of the two experimental conditions - imitation and drawing - homogeneous with respect to details in representations the number of objects in imitation towards which the actions were oriented was calculated and compared with the number of objects in drawing.

The mean number of objects used in drawing and imitation are given in Table 3.

**Table 3. The means and standard deviations for number of objects in imitation and drawing in both age groups.**

<table>
<thead>
<tr>
<th></th>
<th>Age-group</th>
<th>4-year-old</th>
<th>6-year-old</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$M$</td>
<td>$s$</td>
</tr>
<tr>
<td>Experimental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>conditions</td>
<td>Objects in imitation</td>
<td>13.11</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Objects in drawing</td>
<td>13.33</td>
<td>10.49</td>
</tr>
</tbody>
</table>

$N = \text{three test-task sequences}$

A two way (Subjects x Representation mode) Friedman analysis of variance for number of objects in imitation and drawing yielded no significant effects ($X^2 < 0$ in the 4-year-old group and $X^2 = 0.18$ in the 6-year-old group). The analysis indicate that the number of objects used by representing the test-task in imitation and drawing is about of the same magnitude in both representation modes. Nevertheless, as can be seen from the Table the number of
objects used in both experimental conditions is considerably greater in the 6-year-old group than in the 4-year-old one. This is in accordance with the hypothesis of the study.

**DISCUSSION**

The major findings of this study give support to the hypothesis that the representations are similar in gestural imitation and drawing, indicating that these two representation modes could be expressions of one common underlying semiotic function.

As far as the 6-year-old group is concerned, the results show that there is a high degree of similarity in the representation structure in imitation and drawing, both with respect to the degree of integration and to the number of details in representation. This means, that the 6-year-old subjects were able to construct well integrated representations of the test-task in both representation modes, paying great attention to details.

The 4-year-old group, on the other hand, constructed representations that were both global and disintegrated, and they did so in both representation modes. Both with regard to the degree of integration and to the number of details the 4-year-old subjects' representations were, on the whole, similar in imitation and drawing. However, with regard to the degree of integration the 4-year-old subjects' representations in drawing showed a greater variability than those in imitation.

One possible explanation is that the 4-year-old children's previous experience with the symbolic media varied between the subjects. This means, that some of the children mastered the basic rules of symbolization in drawing while others did not. Those children who were used to drawing and
enjoyed it, draw more integrated representations than those children who were not used to the graphic media.

This is in line with Sorce (1980) who has suggested that while a general tendency to transform experiences into symbolic modes may be an intrinsically human capacity, the comprehension and utilization of particular types of representation media (e.g. pictures, gestures) are dependent upon experiential factors. Gardner (1982b), too, has pointed out that children of the same age and comparable capacity react to an identical representation medium in markedly different ways. This indicates that much of the variability in symbolic formation derives from both the representation media and the individual differences.

Similar media effects at work, considering drawing, were found also in our previous studies (study 1 and 2), as well as by other investigators (Franklin, 1973; Gardner, 1982a,b; Golomb, 1973, 1974; London, 1982; Seidman & Beilin, 1984; Shotwell et al, 1980).

Compared with our earlier findings (study 1 and 2) the present findings suggest that representation in imitation and drawing is more similar than the one in drawing and symbolic play. This is in line with Piaget's theory, stating that there exists a closer link between imitation and drawing than between drawing and symbolic play. The two former representation modes are, according to Piaget, characterized by the primacy of accomodation, while symbolic play is characterized mainly by assimilation (Piaget, 1951; Piaget & Inhelder, 1969).

The results further show that the two age groups differ in the overall level of performance, indicating that the semiotic function is more developed in the six-year-olds than in the four-year-olds. The overall level of performance differed between the two age groups already in study 1 and 2. However, since the test-task in these studies was both long and demanding the obtained
differences could be considered as a problem of method. This aspect was eliminated in the present study, since the test-task was replaced with an easier one.

With respect to the development of imitation and drawing the results give clear support for the proposed developmental sequence. This means, that there was a progressive differentiation with increasing age between the signifiers and the self and between the signifiers themselves in both the children's imitation and drawing.

The 4-year-old children's representative gestures were global and self-oriented and they used their body-parts as signifiers. Thus, the 4-year-old subjects represented the test-task sequence "to dress on the jacket, cap and boots" in a disintegrated manner, with three global and temporally isolated motions of the hands - moving the hands against the body, the head and the feet, indicating the dressing procedure.

The children did not make any movements to take out the clothes from the storage space but had them immediately at hand, indicating an insufficient differentiation between the self and the "out-there" space. Moreover, the representative gestures of the 4-year-old children were not yet enactive, i.e. the subjects did not position their hands as if holding the clothes, but used them as if the hands represented the clothes, indicating that the signifiers are not yet differentiated from the self.

In the 6-year-old subjects, on the other hand, these differentiations - between the signifiers, the self from objects and the signifiers from the self - were carried through.

Furthermore, the gestures of the 6-year-old subjects were purely enactive, i.e. they did not, as the 4-year-old subjects, use body parts as signifiers. Instead their gestures were of the pretending type - "as if" holding the
clothes, thereby indicating a differentiation between the signifiers and the self. The depictive gestures, i.e. the signifiers, too, were differentiated among themselves. Thus, the clothes used by the 6-year-old subjects had imagined sleeves, buttons, zippers, ribbons, shoelaces etc.

Moreover, the action sequences of the 6-year-olds were well integrated and continuous with no temporal breaks as was the case with the action sequences of the 4-year-old subjects. All this is quite in line with previous findings and interpretation (Elder & Pederson, 1978; Franklin, 1970; Kaplan, 1968; Overton & Jackson, 1971; Piaget, 1951; Stern, 1973; Werner & Kaplan, 1963).

The same differentiations as in imitation could also be seen in drawing. The 4-year-old subject's drawings were global, undifferentiated and disintegrated in contrast to those of the 6-year-olds, whose drawings were detailed and complex (differentiation of signifiers).

Furthermore, the 4-year-old subjects' drawing process resembled the imitation process in that the subjects were acting out the different test-task sequences rather than picturing them. Thus, when a 4-year-old child was drawing how to wash himself, he was making all the movements necessary, which resulted in a motor-rythmic zigzag scribble over the previously drawn objects (e.g. the hand-basin). Moreover, in no case the 4-year-old subjects' drawings included the child himself, while all of the 6-year-old subjects pictured also the child, indicating that the 4-year-old subjects do not yet differentiate between the activity and the self, compared with the 6-year-olds who do so.

All these observations of children's drawings are in accordance with previous findings (Freeman, 1972, 1976, 1980a,b; Golomb, 1973, 1974; Goodnow, 1977, 1978; Goodnow et al., 1986; Kellog, 1969; Leeds et al., 1983; Monoud, 1971; Oliver, 1974; Smith, 1979).
In summarizing the present findings it could be shown that there is a considerable similarity between gestural imitation and drawing, both with respect to the representation structure and to the representational developmental. This suggests that there could be a common underlying semiotic function, as far as imitation and drawing is concerned.

The somewhat greater variability found in the younger age group's drawing has, at least partly, to do with the children's previous experience with this representation media. However, the representation media in drawing proves itself to be more demanding than the gestural media or the symbolic media used in play (cf. study 1 and 2).

Furthermore, comparing children's drawings in the present study with their drawings in studies 1 and 2, it can be stated that the task demands also seem to play a considerable role. When the test-task was short and well defined (as in the present study), the children solved the task in a strictly planful way, compared with the case when the test-task was loosely structured, allowing deviations. Of course, it is difficult to judge whether the task simplification actually made it easier for young children to exhibit higher level skills or, instead, fundamentally transformed the task, creating a task requiring lower-level skills.

An important task for future studies must therefore involve an examination of the developing knowledge of both the medium and the task demands, and the interaction between the two. Although drawing has been the problematic medium so far in our studies, we assume that many of the problems discussed in the present studies apply to other media as well.

To investigate Piaget's hypothesis of a general semiotic function in a comprehensive way, it is thus necessary to
pay serious attention to the different factors mentioned above. Each medium seems to offer somewhat different possibilities and create somewhat different demands on the child. The same task may have a different meaning in different representation media. Experiences with the representation media may also play a role in representation. There is, thus, an inter-relationship between the task and medium on the one hand, and between the different representation modes on the other. This highlights the difficulty to isolate the medium from the task, and to isolate one representation mode from any of the others. To clarify and/or to resolve the nature of these complex interactions provides a challenge for further explorations in future research.
STUDY 4. Relations between verbal and pictorial information in representation in four-, six-, and eight-year-old children

The earlier studies reported here have given some support to the hypothesis of a general semiotic function, in that they showed (a) that children use same kind of rules in drawing and play-constructions when they are given a story in verbal form to represent (study 2), (b) that the structure of the representation is approximately the same in different representation modes, such as drawing and play-construction (study 1), and imitation and drawing (study 3).

However, these studies also showed that the medium in which the representation takes place is not to be conceived of as invariant, but that some representation media require more mental effort and manual skill than others, and that the medium itself could even have the potentiality of structuring and shaping information in different ways. The studies showed further that also task demands play an important role in symbolization and that these demands may interact with the representation media.

The present study was carried out to investigate a different aspect of the hypothesis of a general semiotic function, compared with our earlier studies, namely that the form in which the information to be represented is given does not affect the rules used. Specifically, the purpose of the present study was to compare the effect of verbal and pictorial information on children's classifications rules (i.e. the operative aspect of cognition).

Most major researchers in cognitive psychology have at some time given children of different ages a group of diverse objects and then studied how the children group the objects
At ages two through four, children usually group items haphazardly. When they are consistent, they usually group items by their most readily perceived properties, i.e. by their figurative aspects, particularly shape, size or color, or they may group them for highly personal reasons ("I put them together because I like them that way") (Annett, 1959; Gardner, 1982a; Piaget & Inhelder, 1964).

Between the ages of about four and seven, the capacity to operate upon materials in diverse and ever more complex ways increases. Still the children about this age use mainly empirical rules to construct representations, and their representations could be called "complexes". (cf. Vygotsky, 1962). A "complex" is a grouping of objects on the basis of their participation in the same empirical or practical operation, drawn from the child's daily experience, e.g. a chair is grouped with a table. The basis for classifications is thus functional (according to empirical rules), rather than formal (Annett, 1959; Aronsson, 1978; Denney, 1972, Kagan et al., 1963; Laflaquière, 1979; Luria, 1976; Markman, 1979; Olver et al., 1966; Piaget & Inhelder, 1964; Vygotsky, 1962; Werner, 1948).

During the "concrete" operational stage, i.e. after the age of seven, the children may still favour empirical classification rules, but they are also capable of, and will tend to favour formal representation rules, thus grouping the items into hierarchical classes. That is, a child can combine one class of objects, such as "a hammer, a screwdriver and tongs" into the superordinate class of "tools" (Vygotsky, 1962; Piaget & Inhelder, 1964; Denney, 1974; Luria, 1976; Aronsson, 1978; Markman, 1979;
Laflaquière, 1979). This ability rests on the operation Piaget calls class inclusion, meaning that the child can consider the same object as a member simultaneously of a number of increasingly broad categories.

Although children move with increasing age from perceptual through functional to hierarchical categorization, and although their categorization becomes increasingly more abstract and subtle, their groupings will still reflect personal style. Thus, some children may still use empirical rules, composing their groupings according to functional criteria, whereas others may classify according to formal rules and end up with class-inclusions.

According to Piaget's hypothesis of a single underlying semiotic function, the children's representations should not be affected by the nature of the information given, i.e. whether the information is given in natural form (objects), or in verbal or pictorial form. However, the matter is neither simple nor thoroughly investigated.

Anglin (1970, 1978) is one of those who addressed this question. His conclusion was that different principles appear to govern the classification of words and objects. According to Anglin, even young schoolchildren will group objects that belong to the same class, but they do not sort words according to the same principle. Instead, they group words that might occur together in sentences or make plausible stories of them, i.e. they will classify the material according to empirical rules. Similar findings have been reported also by others (Berko & Brown, 1960; Denney, 1972, 1974; Kagan et al., 1963; Piaget & Inhelder, 1964; Sorce, 1980; Vygotsky, 1962).

On the other hand, several investigators (Denney, 1974; Gardner, 1982a; Sorce, 1980) have shown that considering classification of verbal and pictorial information one has also to take into account common underlying principles. According to these authors, in both representation modes
(verbal and pictorial), younger children's groupings tend to be personal and the children tend to stress functional relations between the items. With increasing age these classifications loose ground to hierachical organization. It seems, therefore, that there is a similar development trend in children's ability to group items in different representation modes, and that there is, at least, a positive relationship between their performance on these different representation forms.

Piaget himself seemed to reason according to similar lines (Piaget & Inhelder, 1964). He claims, that when the stimuli are geometric like, the transition from empirical to formal rules seem to occur earlier, than when real objects or representations of real objects (words or pictures) are employed. The reason for this difference in time of transition from one kind of rules to another probably has, according to Piaget, to do with the complexity of the stimuli. In the present case it means that the presentation mode itself could exert some influence upon the children's classification ability.

Other investigators (Seidman & Beilin, 1984) have shown that when photographs and drawings were compared, photographs showed to be a more difficult representation form than drawings for young children. A comparison among photographs, drawings, toys and a live model showed that photographs were most difficult as a medium and the live model the easiest for children to understand and to imitate (Kose et al., 1983). The complexity and the degree of symbolic character of the stimulus material is thus a factor that influences the children's performance. The authors conclude that the developing ability to interpret symbolic representations has not only to do with the child's cognitive level but also with the representation media.

As mentioned earlier, Piaget distinguished between figurative and operative aspect of knowledge, and asserted
that there is a constant interaction between the two aspects of cognition. However, there are others who argue that figurative and operative capacities do not necessarily prosper together (see for example Gardner, 1977, 1982a,b; Kelly et al., 1984; Perkins & Leondal, 1977; Salomon, 1978; Shotwell et al., 1980). According to their opinion, it could be that an increase in one form may be at the expense of the other. They argue further, that in our society operative procedures are generally favored, and moreover, they are practiced in schools. Schooling, then, favours the operative aspect of cognition, and this influence could occur at the expense of figurative knowledge (see also Greenfield, 1966; Cole et al., 1971).

Consequently, it could be predicted that preschool children make their classifications mainly on the basis of figurative qualities, being helped thereby in the pictorial representation mode where the figurative qualities dominate. School children, on the other hand, are relying more on operations, thereby minimizing the differences between the two representation modes.

The present study was designed to find out whether the rules (the operative aspect of cognition) the children use in classifying verbal and pictorial information (i.e. two manifestations of the semiotic function) are similar in both representation modes. The rules themselves could be either empirical or formal. A classification task, which could be solved both by empirical and formal rules, was constructed for this purpose. The age groups investigated comprised 4-, 6-, and 8-year-old children.

The main hypothesis of the study was that the children will use the same rules to solve the test-task, i.e. empirical or formal, in both representation modes. That is, if they use empirical rules, they will do so both when the test-task is presented verbally and when it is presented pictorially, and if they use formal rules when the task is
presented verbally, they will do so also when the task is presented pictorially.

The second hypothesis of the study concerns the developmental aspect of cognition. Since the capacity to operate upon items increases during the course of childhood it is reasonable to assume that the 4-year-old children will solve the test task in a haphazard way, the 6-year-old children will use mainly empirical rules, and the 8-year-old children will make increasingly more use of formal rules. This development trend should be similar in both representation modes, i.e. both when the task is presented verbally or pictorially.

**METHOD**

Subjects
Forty-eight middle class children from two nursery schools and an elementary school in Boden, a small town in the north of Sweden, served as subjects. There were three age groups - 4 year olds, 6 year olds and 8 year olds. The children in each age group were divided into two groups of eight children each. One of each age group was given the task in pictorial form, and the other group was given the task in verbal form. For the 4-year-old group with a pictorial mode of presentation the median age was 4.10 years (age range: 4.1 - 5.0), and for the 4-year-old group with a verbal mode of presentation the median age was 4.8 years (age range: 3.9 - 5.0). For the 6-year-old group with a pictorial mode of presentation the median age was 7.0 years (age range: 6.9 - 7.3), and for the 6-year-old group with a verbal mode of presentation the median age was 6.11 years (age range: 6.5 - 7.2). For the 8-year-old group with a pictorial mode of presentation the median age was 8.11 years (age range: 8.7 - 9.2), and for the 8-year-old group with a verbal mode of presentation the median age was 8.11 years (age range: 8.4 - 9.2).
Materials
A classification task, similar to that used by Luria (1976), was constructed. The test-task consisted of four groups of objects, with four objects in each group. The objects in each group could be classified according to a formal rule or an empirical rule. For example: a group of the following objects - 1. a boy, 2. a pair of gloves, 3. a cap, 4. an overcoat - can be classified according to a formal rule: a pair of gloves, a cap, an overcoat to form a class of "clothing", or according to an empirical rule: a boy wearing an overcoat and a cap - or: a boy wearing an overcoat and a pair of gloves - or: a boy wearing a pair of gloves and a cap.

For the verbal mode of presentation, sixteen words served as stimulus material.

For the pictorial mode of presentation, sixteen cards with line drawings of the objects were constructed. The cards were 10.5 by 14.5 cm and coated with plastic. They are illustrated in Figure 1.

Figure 1. Stimulus material for the pictorial representation mode
Design
A mixed factorial design with age and presentation mode as between-subjects factors and presentation order as a within-subjects factor was adopted in this study. The test-task included four groups of objects. The order of the different group presentations was counterbalanced across the 8x3x2 subjects (8 subjects in 3 different age groups and in 2 different presentation modes), according to Latin Square design.

Procedure
Subjects were tested individually in a single session. Before the actual test-task each subject had to solve an introductory task similar to the test-task to make sure that the subject had understood the task.

The subjects in the verbal mode group had to classify objects presented verbally by the experimenter. The experimenter made sure that the subjects were acquainted with the names of the objects. The subjects in the pictorial mode group had to classify drawings of objects. The subjects in this condition were asked to name the objects on the pictures. Every testing session was tape recorded.

The instructions for the test-task were as follows:
The subject was asked to play a game with the experimenter. He/she was told that there were no right or wrong answers in the game. In verbal mode the subject was told names of objects and in pictorial mode the subject was shown drawings of objects. First the subject was given two objects (words or pictures) and the experimenter kept rest (two objects). Then the subject was asked the following questions:

1. Look, here you have those things (a boy and an overcoat) and I have those two (a cap and a pair of gloves). If you
have to choose one of the objects I have that goes together with those you already have, which one would you choose?

2. Why did you choose this one?

3. The subject is given all four objects (words or drawings) and the experimenter asks: If you have all four things and have to give one of them away, the one that does not go well together with the rest of them, which one would you give away?

4. Why do you give away this one?

By these questions the subjects were given the opportunity to classify the objects twice, once by choosing one object in addition to the ones they had, and the second time by giving away one of the objects. It has to be noted that the second classification (to give away one object) differs from the first one in that the proportion empirical vs. formal rules is 3:1, i.e. three objects can be given away according to empirical rule and only one object can be given away according to formal rule.

RESULTS

Differences between representation modes
The means and standard deviations for formal and empirical classifications, as defined by the test-task, question number one, in both experimental conditions and all age groups are given in Table 1.
Table 1. The means and standard deviations for formal and empirical classifications in the verbal and pictorial mode for classifications in different age groups.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 years</td>
<td>M 1.50</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>s 2.40</td>
<td>2.44</td>
</tr>
<tr>
<td>6 years</td>
<td>M 0.87</td>
<td>3.13</td>
</tr>
<tr>
<td></td>
<td>s 1.72</td>
<td>1.70</td>
</tr>
<tr>
<td>8 years</td>
<td>M 1.50</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>s 3.16</td>
<td>3.16</td>
</tr>
</tbody>
</table>

As can be seen from the table, empirical classification rules were used considerably more often than formal rules in all age groups. Further, visual inspection of data indicates tendencies of differences between the two representation modes, and a possible tendency of an interaction between Age and Representation mode. However, a two way Age x Representation mode analysis of variance for number of formal classifications in verbal and pictorial representation mode yielded no significant effect of Age ($F(2, 24) < 1.00$) nor of Representation mode ($F(1, 21) < 1.00$), nor any interaction between Age and Representation mode ($F(2, 21) = 1.55$). The statistical analysis indicate, thus, that the number of formal classifications used to solve the test-task was about the same in both representation modes, thereby, supporting the hypothesis of the study.

To assess whether the classifications were consistent through the different test-task sequences (groups of objects to be classified) the number of subjects in each
age group choosing each form of classification in three out of four test-task sequences in verbal and pictorial representation mode was calculated. The results are given in Table 2.

Table 2. Number of subjects in each age group choosing either formal or empirical classification mode in three test-task sequences of four possible in verbal and pictorial representation mode.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>6-year-old</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8-year-old</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

As can be seen from Table 2, the number of consistent classifications is very high in all age groups, and this is true for both representation modes.

By question number two the subjects were asked to give an explanation of each of their classifications. If the subject classified the items according to a formal rule, he/she had to give an answer alluding to the class name. If, on the other hand, the subject classified the items according to an empirical rule, he/she had to answer according to a functional criteria, for example "the boy needs a cap".

The results are given in Table 3.
Table 3. Proportion correct answers for formal and empirical classifications in verbal and pictorial representation mode in different age groups.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formal classification</td>
<td>Empirical classification</td>
</tr>
<tr>
<td>4-year-old</td>
<td>.00</td>
<td>.82</td>
</tr>
<tr>
<td>6-year-old</td>
<td>.85</td>
<td>.96</td>
</tr>
<tr>
<td>8-year-old</td>
<td>.83</td>
<td>.91</td>
</tr>
</tbody>
</table>

As can be seen from Table 3, the 4-year-old subjects cannot explain their formal classification rules, but they give a correct answer when they make use of empirical classification rules. In the 6- and 8-year-old group, the subjects' classifications are followed by a correct explanation, both when they use the different classification rules, and when they classify words or pictures.

By question number three the subjects were asked to classify the test-task items once again, now by giving away one of the objects that did not fit with the rest. The results of this classification are given in Table 4.
Table 4. The means and standard deviations for formal and empirical classifications to question 3 in verbal and pictorial representation mode in different age groups.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-years</td>
<td>M 0.88 3.13</td>
<td>0.71 3.38</td>
</tr>
<tr>
<td></td>
<td>s 2.62 2.62</td>
<td>1.97 2.00</td>
</tr>
<tr>
<td>6-years</td>
<td>M 0.38 3.63</td>
<td>1.75 2.25</td>
</tr>
<tr>
<td></td>
<td>s 1.37 1.37</td>
<td>3.94 3.94</td>
</tr>
<tr>
<td>8-years</td>
<td>M 1.25 2.75</td>
<td>1.88 2.13</td>
</tr>
<tr>
<td></td>
<td>s 4.64 4.64</td>
<td>4.78 4.78</td>
</tr>
</tbody>
</table>

As can be seen from Table 4 the results are similar to those of Table 1 in that the subjects use considerably more often empirical classification rules in both representation modes and in all age groups, despite the fact that the probability to classify according to empirical rules was 3:1.

Considering the differences between the two representation modes a two way Age x Representation mode analysis of variance for number of formal classifications in verbal and pictorial representation modes was carried out. The analysis yielded no significant effects, indicating that the number of formal classifications used to solve the test-task was of the same magnitude in both representation modes, as predicted by the hypothesis of the study.

The degree of consistency was calculated by the same way as for question number one. The results are given in Table 5.
Table 5. Number of subjects in each age group choosing either formal or empirical classification mode in three test-task sequences of four possible in verbal and pictorial representation mode for question nr 3.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-year-old</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>6-year-old</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>8-year-old</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

As can be seen from Table 5, the number of consistent classifications is very high in all age groups and both representation modes. All subjects made consistent classifications in the verbal representation mode and nearly all subjects did so in the pictorial mode of representation.

The proportion correct answers given to each classification mode (question 4, analogous to question 2) are summarized in Table 6.

Table 6. Proportion correct answers for formal and empirical classifications in verbal and pictorial representation modes in different age groups.

<table>
<thead>
<tr>
<th>Age group</th>
<th>Verbal mode of representation</th>
<th>Pictorial mode of representation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formal classification</td>
<td>Empirical classification</td>
</tr>
<tr>
<td>4-year-old</td>
<td>.00</td>
<td>.40</td>
</tr>
<tr>
<td>6-year-old</td>
<td>.67</td>
<td>.69</td>
</tr>
<tr>
<td>8-year-old</td>
<td>.90</td>
<td>.77</td>
</tr>
</tbody>
</table>
It can be seen from this table that the results are, on the whole, consistent with those in Table 3. The 4-year-old subjects can not give any explanations for their formal classifications, and as far as their empirical classifications are concerned they can explain them about half of the time. That is, their ability to give correct answers to their classifications shows a declining tendency from the mean proportion correct answers of .87 (Table 4) to .46 (Table 6). In the 6- and 8-year-old group the classifications are followed by the correct answers most of the time.

**DISCUSSION**

The main hypothesis of the study proposed that the subjects would use the same classification rules to solve the test-task in both representation modes, i.e. both when the test-task was presented verbally and when it was presented pictorially. The present findings are in general agreement with the hypothesis of the study.

In the previous studies reported (study 1, 2, 3) the test-task was presented verbally to the children and they had to produce a representation of it in different representation modes: in drawing, play-construction and imitation. Thus, the children had to construct their representations themselves, making use of symbols in various media.

In the present study the children were presented with ready made symbolic products (words and pictures) and had only to classify them. That means, that the information was given in different modes: verbally and pictorially, and the children had to solve the test-task in the same mode, i.e. verbally. The results showed that the same kind of rules were used to solve the test-task both when it was presented verbally or pictorially, and by all age groups. This indicates that the media effects, found in our previous findings, seem to disappear, or at any rate, to be of
minimal importance when ready made symbolic forms are used, and when the children are not asked to make use of the skills required to master the different representation media. The present findings indicate, therefore, that the representation rules are not affected by the form in which the information is given.

Consequently, we can hypothesize that the skill required for operating with ready made symbolic forms in separate representation modes, differs from the skill required to first create the symbolic forms, and then to operate with them. When ready made symbolic forms are used (words, pictures, toys), the differences between the representation modes seem to be small, maybe even disregardable, at least as far as the representation modes described by Piaget are concerned (cf. Golomb, 1973). Studies of others, mainly artistic representation modes, such as music, painting, sculpture and dance, show a somewhat different picture (see for example Gardner, 1977, 1982b; Howard, 1977; Salomon, 1978).

The present findings do not, however, confirm the research of Anglin (1970, 1978), Kose, Beilin and O'Connor, 1983, and Seidman and Beilin (1984). According to these investigators there were clear differences in the children's performance between such representation modes as words, photographs, drawings, objects and live models. However, in their research the operative aspect of representation was not explicitly investigated. In most cases the children had to put together the stimulus material without any specific instruction (Anglin, 1970), or simply to talk aloud about what they were doing or thinking when classifying or describing the material (Kose et al., 1983; Seidman & Beilin, 1983). In the present study the children were presented with a well defined operative task. This fact might in part explain the differences between the present findings and the earlier research.
Viewing the present findings with regard to the figurative and operative aspect of the problem we can also draw attention to the following: Since the pictorial representation mode carries more figurative information than the verbal mode, the last being more abstract (cf. Gardner, 1982a; Halford, 1989), it could be predicted that, at least the youngest age group would benefit more by the figurative information, and make their classifications in this representation mode more often on basis of figurative aspects. However, this proved not to be the case. The data showed that the 4-year-old subjects' representations were similar in both representation modes.

There might be several explanations for this finding. One of these could be the fact that in the present case the children were asked to operate on the stimulus material, i.e. to classify the items. Whether the same results are obtained when the figurative aspect of the problem is examined, remains to be investigated. It might be, as far as the pictorial mode is concerned, that the younger children can, for example, memorize the material better or remember more details in it, i.e. be figuratively superior to the older group. The present findings reflect only the operative aspect of the problem.

Comparing the present study with the earlier studies reported (study 1, 2, 3), it can be stated that when the test-task is well defined and restricted (i.e. minimizing the child's freedom to make idiosyncratic choices) the representations in separate representation modes increase in similarity. Furthermore, there seems to be a greater similarity between the different representation modes in the operative aspect (Study 2 and Study 4) compared to the figurative one (Study 1 and Study 3). However, since the two aspects are interacting (i.e. the rules and the content of a task) the conclusions drawn are inevitably, at least to a certain degree, confounded.
In summarizing so far it can be stated that the findings of the study give, in an indirect way, support to Piaget's hypothesis of a single semiotic function. This is true, as far as the operative aspect of the problem is concerned, and as far as the stimulus material is presented in ready made symbolic form. However, the figurative aspect of the problem, i.e. whether the content of the representation is affected by the form in which the information is given remains to be investigated in future research.

The second hypothesis of the study proposed that the 4-year-old subjects will solve the test-task in a haphazard way, the 6-year-old subjects will use mainly empirical rules, and the 8-year-old subjects will make increasingly more use of formal rules, and that this will be the case in both representation modes. The obtained results did not confirm these assumptions. Instead it was shown that empirical representation rules dominated in all age groups, and in both representation modes, and that the subjects' classifications were considerably consistent through the different test-task sequences. This can partly be due to the test-task design. Similar findings among adults have been reported also by Denney (1972, 1974).

It has repeatedly been shown by previous research that children up to about seven years rarely stick with the same basis for classification throughout a series of groupings, i.e. their classifications are not consistent (Bruner et al., 1966; Denney, 1972, 1974; Piaget & Inhelder, 1964; Vygotsky, 1962). These studies show that children may link two elements appropriately but then shift the basis for linking these as they attempt to incorporate a third. First at the concrete operational stage the children will tend to use the same basis throughout a series of trials.

In the present study the children's classifications were consistent (three out of four test-task sequences) in all age groups. Inspecting the data more closely it can be seen
that although the subjects in the 4-year-old group classified the items in a consistent way, they nevertheless could not give a correct criterion for their formal classifications, as can be seen from Table 3 and 6. When asked to classify the items once again (giving away one item), their empirical classifications too, were explained correctly only half of the time (Table 6). Thus, in spite of the fact that the 4-year-old subjects' classifications are consistent through the three test-task sequences, we, most of the time, really do not know why they are classifying as they do.

Another reason why the present findings do not coincide with the general findings in many classification studies can be due to the test-task instructions. In most of the earlier studies the general procedure is to present children with forms, objects of pictures, and ask them to put together those that are "most alike" or that "belong together" (Bruner et al., 1966; Piaget & Inhelder, 1964; Luria 1976). The classification is then, in certain respects, free.

In the present study the child had either to choose only one item to complete a grouping, or to give away one of the items for the same reason. Furthermore, the children were asked to explain the rationale for each of their classification. Thus, the classifications were, compared with earlier studies, more restricted, indicating that under these conditions the subjects may be guided to use a more consistent classification criterion.

Even with regard to representation rules there were deviations between the present findings and the classification studies mentioned earlier. The findings can be interpreted as follows:

Since both kind of classification rules were correct, i.e. the test-task could be solved by both of them, and since no instructions were given stressing the desirability of the
one, rather than the other rule, the subjects could choose (at the first classification opportunity) whatever kind of rule they wanted. Since empirical classification rules dominated in all age groups and in both representation modes, it seems that this kind of rules are more easily expressed with the present kind of information (cf. Denney, 1974). The similarity in results between the first and second classification could be due to a transfer effect between the two conditions (empirical vs. formal rules in the second classification was 3:1).

From a strictly theoretical point of view, the 8-year-old subjects should be able to solve the test-task according to the formal rules, thus classifying the objects into their superordinate classes. The fact that they did not always do so suggest, too, that the content of the representation, i.e. the character of the objects to be classified, somehow may have led them to use empirical representation rules rather than formal ones.

It seems, therefore, possible that the subjects in our experiment use mainly empirical rules because to do so constitutes a more "natural" way of organizing one's experience, than categorizing according to formal rules. The 8-year-old subjects' failure to use formal rules may not reflect their inability to do so, but can be due to the absence of educational pressure to use these relatively less natural, less obvious rules. Thus, the use of different classification rules may very well be a result of external, environmental conditions, rather than a result of internal cognitive changes. Similar findings have been obtained also in other studies (Cole et al., 1971; Denney, 1974; Luria, 1976; Olver et al., 1966).

Summarizing the results discussed above, it can be concluded that the present findings do not contradict Piaget's hypothesis of one common semiotic function for representation, as far as verbal and pictorial information is used, and as far as the operative aspect is concerned.
However, several questions remain unanswered. One of these, important in the present context, can be formulated as follows: Is there a difference between the childrens' representative activities (both figural and operational) in different representation modes when the information is given by ready made symbolic forms, compared to when the child has to create the symbols himself? Another question has to do with the character of the test-task and can be put as follows: Is a well structured test-task measuring the same aspects of representation as a lengthy and vaguely structured one? A third question has to do with figurative and operative knowledge and can be formulated as follows: How can the rules of a task be studied unconfounded from the content? These questions constitute an important issue for future research.
DISCUSSION

The purpose of the present thesis was to study the relations between the different representation forms of the semiotic function and tentatively relate them to Piaget's hypothesis. This was done both theoretically and empirically.

The time interval, from when I started to study the problem until I arrived to the point when I was ready to draw general conclusions about it, comprised (for several reasons) many years. This long delay before arriving at closure, enabled me to see the relationship between the tentative beginning points of view, the primary observations, the facts arrived at through empirical investigations, the problems connected with Piaget's hypothesis, and finally, several distantly related ideas about the problem.

The aim of the last part of the thesis is threefolded:

First, my intention is to summarize and discuss the theoretical considerations and the present findings. Second, I will discuss the unsolved problems included in these findings. Third, I will consider the related research in this area of the semiotic function, not yet considered in the present thesis.
Summary and discussion of theoretical assumptions and earlier findings

Theoretical background
According to Piaget all forms of mental representations express one single underlying function, called the semiotic function. The various representation forms which Piaget himself attributes to the semiotic function, and considers being interrelated are: deferred imitation, symbolic play, drawing, mental image and language.

The semiotic function emerges at the beginning of the preoperational development stage, and extends through the whole childhood into the mature thinking of an adult. It helps the child, as well as the adult, to think and live in a world of symbols. Piaget's aim was to investigate the young children's ability to construct and to make use of symbols and he followed this construction process during the different developmental stages.

Piaget developed his theory in order to provide a psychological approach to problems of epistemology. His theoretical account can be understood as an interactionist theory, in which the activity of the child is in focus. Piaget argued that knowledge is neither found solely in the subject, nor in the supposedly independent object, but is constructed by the subject as an indissociable subject-object relation. The past experiences of the child play a role in the content of the forms of the activity observed, but the structures of behaviour and the sequence of the development stages are worked out by the child in his interaction with the world around him.

Piaget's theory can thus be seen as a kind of constructivism. Accordingly, he regarded mental representation as a cognitive construction. In order to construct representations one needs both the material and
the rules for construction. On that account, Piaget made a distinction between the figurative and operative aspects of knowledge. Figurative aspects of thought are static and refer to the product of the semiotic function. Operative aspect of thought, which for Piaget was the essential aspect of logical and prelogical constructive knowledge, involve transformations. That is, they involve rules according to which the transformations take place and the representations are constructed. In the present thesis this distinction plays an important role.

As stated earlier, several scholars have criticized Piaget's hypothesis of a single underlying semiotic function on theoretical grounds. Many of them have also offered alternative theoretical explanations to symbolic activities. These opponents to Piaget descend mainly from four different theoretical approaches: (1) the cognitive-structural approach (2) the empiricist approach (3) the nativist approach, and (4) the artistic approach.

**The cognitive-structural approach**

According to Bruner (Bruner et al, 1966), there is not one single function for representation, but three different (sometimes interacting) systems of representation. These systems should be viewed as three distinct stages of development with different modes of knowing respectively. Bruner argued further, that these systems of representation are not considered to be universal ways of representing reality, as Piaget considers the semiotic function, but are heavily culture bound.

As far as the cultural aspect is concerned we agree with Bruner, that culture reasonably should have a considerable influence on representation. Nevertheless, we do not see why a unitary semiotic function could not be culture bound as well. This argument of Bruner does not, in our opinion, contradict Piaget's hypothesis of the semiotic function.
Beyond Bruner also a number of others (see for example Cole & Scribner, 1974; Gardner, 1979, 1980a,b; Shotwell et al., 1980) have criticized Piaget for leaving out cultural and social factors in cognition and paying little attention to individual differences. This criticism is well known in post-Piagetian psychology.

Despite the massive criticism directed against Piaget on this account it is tempting to agree with Furth (1973, 1986) in his defence of Piaget's approach. In Furth's view, the basic nature of a phenomenon has first to be understood (as Piaget's theory does), before studying its range of variations - may they then be individual or cultural.

In applying Piaget's theory to individual or cultural differences Furth makes use of Piaget's distinction between operative and figurative knowledge. Operative knowledge is (according to Furth) universal, since it refers to the action and transformation aspect of knowledge, which is common to all individuals. Piaget's theory was essentially concerned with the form (or organization) of knowledge (the operative aspect), and not with its specific content (the figurative aspect). Figurative knowledge, which refers to particular contents, can be both individual and culture-bound. Thus, the behavioral and thinking mechanisms (the operative aspect) determine how to think or act, but what an individual actually is thinking or what he is learning (the figurative aspect) varies as a function of culture and differences in individual history or make up.

According to Furth, Piaget's theory, although it is complex and difficult, includes these two aspects - logical necessity (the operative aspect) and construction of novelty (bound to the figurative aspect). In Furth (1986) own words:
"In humans the constraint of logical necessity is the stable anchor against which the indefinite openness of new possibilities is being constructed — in history and in individual lives." (p. 28)

According to Furth there is thus a dimension of stability or absoluteness (the operative aspect) in Piaget's theory, which is uninfluenced of historical, societal or individual differences. But this aspect is, as Furth (1986) puts it "a content-empty formula". Applying the formula (i.e. the organizational principles) to a specific content "we are back in the realm of dynamic world of relative certainty".

Kelly, Brown and Foxx (1984) reason according to similar lines. They too argue that operative knowledge is a form or process of reasoning and figurative knowledge relates to cultural content. Furthermore, according to these authors, to be able to use formal structures (operative knowledge) in a significant way requires high level familiarity with the content, and for some contents, not all formal structures are required.

This reasoning of Furth (1973, 1986) and Kelly et al. (1984) is certainly intriguing and it was used as a guiding hypothesis throughout the work with this dissertation.

From the cognitive-structural approach another theoretical problem of particular interest has for a long time been the relation between language and thought. Vygotsky (1962) is one of these who disagreed with Piaget on this matter. According to Vygotsky, thought and language have different origins and develop from relative independence in early childhood to a fusion and integration in adulthood. Piaget's theory of the semiotic function claimed that language is one form of this function and as such, together with other forms, structured by thought. (This particular issue will be considered later).
Another point where Vygotsky's (1976) view differed from that of Piaget, was about symbolic play. According to Vygotsky, symbolic play is a leading factor in development, which continually creates demands on the child and has inherent rules which the child has to follow. This was not the view of Piaget. According to Piaget, symbolic play represents a distortion of reality to the needs of the immature ego, and it fades away after the preoperational development stage.

With respect to children's play-constructions study 1 and study 2 of the present thesis showed that the preoperative child's play is governed by rules, as Vygotsky claimed, and not only a distortion of reality, dependent on the immature and non-purposeful thought of the preschool child. In accordance with Vygotsky we argue that, children at the preoperational development stage are operating with the meanings of things and that their reasoning follows empirical rules which are bound to every-day reality. This does not, however, disregard play as one of the manifestations of the semiotic function. Instead it is proposed that a reconciliation between the viewpoints of Piaget and Vygotsky would afford a more comprehensive understanding of the development of the semiotic function (during the preoperational developmental stage) than does either of these approaches when considered separately (see also Levine, 1984; Segal, 1982).

The empiricist approach
In contrast to Piaget, empiricist theories have stressed the impact of the material world on the experience of the child. As far as mental representation is concerned they favour the position that mental representations are ultimately modality specific in character. From the empiricist's position Paivio's (1971) dual-coding theory can be considered as an alternative to Piaget's theory.
According to Paivio, there are two modality specific representational systems - one nonverbal and the other verbal - and not one single system as Piaget claimed.

The empirical evidence for the two opposing theories is, however, inconclusive. Moreover, a critical test which can distinguish between Paivio's and Piaget's theory, is still lacking. In our opinion both theories can be correct in certain respects. The dual-coding model of Paivio could be correct in claiming that the verbal information is stored separately from the images (the nonverbal information). This assumption does not, as far as we can see, contradict Piaget's theory. The semiotic function of Piaget is considered to be a single underlying conceptual system which is more abstract than the words of language or the images of objects (i.e. the two systems that Paivio describes). Viewed in this way, the semiotic function could be the underlying system from which both the verbal and imaginal representation systems descend.

The nativist approach
From the nativist approach Chomsky is critical to Piaget about the role of language in cognition. According to Chomsky, language is a capacity immanent in the brain, and as such unfolding in a natural way during the course of development. Language is for Chomsky divorced from other forms of thinking and is therefore in no way intermingled (at least not at the start) with other cognitive capacities. Language requires, to be sure, a triggering environment (exposure to speech), but there is, according to Chomsky no need for active construction by the child, or for more specific social or cultural input. Nor are there separate stages of development based on changes in the child's mental capacities and on interaction with the environment (cf Chomsky, 1980; Gardner, 1982b).

The nativist point of view of Chomsky, was an anathema to Piaget, as was the rival empiricist view. According to the nativists' view, development is merely an inherent
maturational process, with no need to prior experience or active construction by the subject. Empiricism, on the other hand, considers the organism as solely a passive receiver to environmental contingencies. Knowledge is then something that is provided in the external world.

Piaget rejected both alternatives. For Piaget knowledge is an active construction that takes place in the constant interaction between the individual (be it a child or an adult) and the world around him. The position taken in this thesis is in agreement with this view.

The debate between Chomsky and Piaget considering the origins of language and its role in cognition, and the whole debate between language and thought (cf. also the view of Vygotsky), has in the 20th century epistemology been undergoing several transformations. The recent surge of interest has focused attention from individual and private experience to the importance of linguistic communication and the public transmission of ideas (cf. Smillie, 1984).

Vygotsky is one of those whose work is important in this respect. According to Vygotsky the unification of thought and speech in children occurs by means of word meaning, and this in turn is dependent of communication between the child and the caretaker. Vygotsky (1962) argued that "...meaning is an inalienable part of a word as such, and thus belongs in the realm of thought" (p. 5). It is therefore the process of naming or word meaning which, according to Vygotsky, allows for the interrelation of thought and language. In this respect, the view of Vygotsky accords with the increasing acceptance among linguistics, who have suggested that semantics (or word meaning) provides an important link between language and thought (cf. Segal, 1982).

In line with Piaget, we argue that language plays a necessary but not sufficient part in cognition. It is
acquired and used like other symbolic behaviors. Nevertheless, Piaget's perspective is somewhat limited, since he does not take into account the social-communicative aspect of language development. Although the relationship between human thought and language has yet to be fully unraveled, Piaget, Chomsky and Vygotsky have shed light on its early stages, and their different viewpoints should be linked together to afford a more comprehensive understanding of the issue.

As far as the semiotic function is concerned, the role of language, as one of its manifestations, is still unexplored. Since all manifestations of the semiotic function develop simultaneously, they interact with another in different ways and an attempt to isolate them, and to isolate language from thought, is difficult and becomes more and more so with progressive development (cf. Segal, 1982).

**The artistic approach**

Those who investigate children's development in drawing, play, gestural expression and other creative activities, have criticized Piaget's theory for being based solely on logico-mathematical structures (Gardner, 1973, 1979, 1980a,b; Levine, 1984; Peacock, 1984; Perkins & Leondal, 1977).

Piaget viewed the child as a young scientist, constructing ever more powerful theories of the world, by the application of a set of logico-mathematical tools of ever increasing power. According to the artistic approach, artistic development involves different kind of thought processes which are based on different kind of logic than the one described by Piaget. According to this approach Piaget's hypothesis of the semiotic function has to be elaborated in ways which take into account also these kind of thought processes important in creative thought (Gardner, 1979; Levine, 1984). We agree with this position.
Gardner (1977) has suggested that the dimension of figurativity/operativity plays a crucial role both in scientific and artistic development. Figurative knowledge is, according to Gardner, more important in the arts than operative knowledge, which in turn is important in scientific reasoning. Gardner's argumentation is in accordance with our view.

Summary and discussion of empirical studies
The purpose of the empirical work was to study the relations between the different manifestations of the semiotic function and thereby explore whether there could exist a single underlying semiotic function for representation or not. The theoretical consideration described in the first part of this thesis, and summarized and discussed in the preceding section, constituted the background and the basis for the empirical studies.

One of the guiding lines for the experiments performed was the distinction made by Piaget between figurative and operative aspects of representation. This theoretical distinction between the figurative and operative aspects led us to the following hypothesis:

* If both aspects of representation (figurative and operative) develop in a similar manner in different representation modes, it would provide a strong support to Piaget's idea of a common semiotic function.

* If the operative aspects of representations, i.e. the representation rules, are similar in different representation modes, and the figurative aspects (the content of representation) are dissimilar, it might still support Piaget's hypothesis of a single semiotic function. A major reason for this is, that while any two representation modes may have similar
principles of operation (the operative aspect), the actual construction, i.e. the combinatory possibilities and the end product of it, may be quite different due to the possibilities and demands of the two representation media (the figurative aspect).

* If neither the figurative nor the operative aspects are similar in the different representation modes, it would led us reject Piaget's hypothesis of a single underlying semiotic function.

**Study 1**
The aim of the first study was to investigate the figurative aspect of representation in two representation modes - drawing and play-construction. A more specific purpose was to investigate how children's representations in these two modes were structured, emphasizing primarily their spatial coherence.

For this purpose two groups of children (four- and six-years-old) were tested with the same test-task. The test-task was a narrative which described an outdoor scene. The subjects were tested individually and had to make a drawing of the test-task scene (experimental condition 1), to build the scene asking the experimenter for the toys needed for this purpose (experimental condition 2), and to build the scene by choosing the toys from a collection of toys (experimental condition 3).

The main hypothesis of the study stated, that if the results will be similar in all three experimental conditions with respect to their structural properties (the spatial coherence), this would support Piaget's hypothesis of a common semiotic function for representation in these two representation modes.

The main results of this study showed that the figurative aspect of representation (the content of it) was similar in both drawing and play-construction, in both age groups.
According to the second hypothesis of the study, stating that the coherence of the representations will be a function of age, it was shown that the younger age group was unable to construct spatially coherent representations in either representation modes, while the older age group could do so. As far as it can be ascertained there has been no previous research investigating this issue.

However, already in this first study the role of the representation media, especially the one in drawing, proved to be problematic. The younger age-groups' drawings were so idiosyncratic, that without considering the entire drawing process and noticing the subjects' verbal comments, the drawings would be quite incomprehensible to the experimenter and very hard to score. This was in line with earlier research (Barrett, 1983; Cox, 1981; Gardner, 1979; 1982a,b; Golomb, 1973, 1974).

The main results of this study can be interpreted as follows: Since there was a distinct similarity between the different representation modes, i.e. the representations were structured in a similar way and developed similarly, the results of this study are not contradicting Piaget's hypothesis of one common semiotic function - rather the results seem to support this view. However, before anything more definitive can be said about it, the operative aspect of the problem has to be considered. This was done in study 2.

**Study 2**

The general purpose of study 2 was to investigate the operative aspect of representation. In this study the data from the first study were reanalysed, now with focus on the operative aspect of the problem. In doing so, we argued as follows: If different representation modes (drawing and play-constructions) are determined by one single semiotic function, it would be expected that children's performances in these representation modes are constructed by the same
kind of rules (the operative aspect). We would also expect to find a similar development of these rules in the two representation modes.

The results showed that the representation rules used by the two age groups were similar in the two representation modes compared. As far as the developmental aspect is concerned, a similar development trend was found in the representation rules in both representation modes. The obtained results indicate therefore that there might be a common semiotic function for representation in drawing and play-construction, as far as the operative aspect is concerned.

However, even in this kind of analyses considerable media effects were found. Since drawing was the most difficult medium for the younger age group, the number of empirical rules (resulting in task-incorrect representations) was smallest in this medium. Play-construction, with visible toys to choose from, constituted the easiest medium, eliciting a large number of empirical rules. This indicates that when the child has to construct his representations in an easy medium, he will be more likely to utilize his operative knowledge (empirical rules), compared when he has to operate in a harder medium (cf. Sorce, 1980).

Since it was only the number of representation rules that differed in different representation modes and not the kind of these, this indicates that the operative aspect of representation, i.e. the underlying organization principles, are the same regardless of representation media (cf. Furth, 1973). The number of rules used in different media (drawing and play-construction) seems to be determined by the character of the medium.

Taken together, the results from study 1 and 2, supported Piaget's hypothesis of the semiotic function. Study 1 gave support to the figurative aspect of representation, and study 2 gave support to the operative aspect. It was also
shown that the impact from the media on the mode of representation affected only the figurative aspect of representation. This means that the dissimilarities in the results were found only in the end products of the representations, and not in the construction principles.

These findings indicate that only the figurative aspect varies as a function of media, while the operative aspect is invariant. This is in line with Furth's (1973, 1986), Gardner's (1977) and Kelly's et al. (1984) reasoning, proposing that operative knowledge is universal whereas figurative knowledge is culture-bound, and determined by pre-existing abilities with a representation medium (see also Gardner, 1982b; Sorce, 1982).

In studying the semiotic function and its development it is therefore, in our opinion, important to study the operative and the figurative aspects in an unconfounded manner (as far as this is possible). Furthermore, since media effects play a considerable role in representation it is questionable if different representation modes of the semiotic function can be investigated in a strictly parallel fashion, at least as far as the children's preexisting knowledge with different representation media is not comparable.

The findings of these two studies show that there are similarities between drawing and play-construction, which in turn suggest that there might be an underlying semiotic function for these two manifestation forms. However, the results also suggest that the media problems and task demands cause such difficulties of both theoretical and empirical kind, that the matter should be considered more carefully in future research.

**Study 3**

In study 3 the relation between gestural imitation and drawing was investigated. This study could be considered as
a parallell to study 1, both with regard to the purpose and the course of action.

The purpose of the study was to investigate the representation structure (the figurative aspect) in the two representation modes. It was hypothesized that if imitation and drawing are both manifestations of the same semiotic function, the representation structure in both these modes should be similar. Since the test-task used in study 1 (and 2) showed to be both long and vaguely structured, it was replaced in this study with a shorter and more well structured one.

The results of the study showed that there was a considerable similarity between gestural imitation and drawing, both with respect to the representational structure (the figurative aspect) and to the development trend found in 4- and 6-year-old children's representations. The results indicate, therefore, that there might be a single underlying semiotic function for these two representation modes. There has, however, (as far as can be ascertained) not been any earlier research investigating this issue.

Even in this study there was found a certain, although slight response variability in drawing, not present in imitation, among the 4-year-old subjects' representations. This finding indicates that there are similar media effects at work as discussed earlier (study 1 and 2). However, this variability was considerably smaller than in study 1 and 2, indicating that the more well-structured and shorter test-task in study 3 made the two compared conditions more equal. Similar effects of task demands are found also by others (Barrett, 1983; Freeman, 1980a,b; Golomb, 1973). Nevertheless, the interaction between medium, task, and representation modes remains a problem which should be examined more carefully in future research. This problem is noticed also by others (Franklin, 1973; Golomb, 1973; Gardner, 1982b; Seidman & Beilin, 1984; Sorce, 1980).
In summing up, the findings of study 3 gave some support to Piaget's hypothesis of the semiotic function, in these two representation modes, as far as the figurative aspect is concerned. However, before drawing more definitive conclusions about the semiotic function in these two representation modes also the operative aspect of the problem has to be investigated. This means, that it has to be delineated whether there is a correspondence even between the representation rules in these two modes of representation.

**Study 4**

In the last study a different aspect of the semiotic function was investigated. In earlier studies the test-task was presented verbally and the children had to represent the task in different representation modes - in drawing, play-construction and gestural imitation. In this study the test-task was presented in different representation modes - verbal and pictorial - and the children had to represent the task verbally.

The purpose of the study was to compare the effect of verbal and pictorial information on children's classification rules, i.e. the operative aspect of representation. The main hypothesis proposed that the children (4-, 6- and 8-year-old) would use the same kind of rules to solve the test-task in both representation modes. A second hypothesis proposed that the development of these rules should be similar in both representation modes.

The results confirmed the main hypothesis of the study. No media effects were found in this study, i.e. the children's performance was similar in both representation modes. It seemed as these effects will disappear when ready made symbolic forms are used (in the present case words and pictures) (cf. Golomb, 1973). The second hypothesis, proposing that the development of representation rules
should be similar in both representation modes, was also confirmed although the rules did not develop the way predicted by Piaget (cf. Denney, 1974).

Summarizing the findings, we could conclude that this study supported in an indirect manner Piaget's hypothesis of one common semiotic function, as far as the operative aspect is concerned and as far as the verbal and pictorial information is used. Nevertheless, we still do not know why the media effects disappeared. Are we measuring the same aspects of representation with ready-made symbolic forms, compared with when the child has to construct the symbolic forms himself? Is a well-defined test-task (as was the case in the present study and in study 3) measuring the same aspects of representation as a more vaguely structured test-task (used in studies 1 and 2)? These questions remain to be investigated in future research.

General conclusions of studies 1 - 4
The main conclusions to be drawn from the four studies are that they all support, however tentatively, Piaget's hypothesis of a single underlying semiotic function for representation.

In studies 1 and 2, both the figurative and the operative aspects of the children's representations were investigated. The operative aspects were similar in both representation modes, whereas the figurative aspects were only correlated. The insufficient correspondence with respect to figurative aspects of representation indicates that this weak correspondence is due to media effects and task demands in these two representation modes.

In study 3 the figurative aspect of representation in drawing and deferred imitation was investigated. The results showed a strong relationship between the figurative aspects in the two representation modes investigated. The slight variability in drawing indicates similar media effects as those found and discussed in studies 1 and 2.
In study 4 the operative aspect in two additional representation modes was investigated. The results showed a correspondence with regard to the operative aspect.

In retrospect we can criticize our empirical studies for not being orthogonal. In study 1 and 3 we investigated the figurative aspect in a parallel fashion, although the test task differed between the studies. In study 2 and 4, where the operative aspect was investigated, the studies were, however, no longer parallel. This weakness, not observed when the experiments were designed and carried out, constitutes an error in our conceptualization at that time, and may influence the strength of our conclusions.

Another weakness in our studies was that no effort was made to ensure that the subjects' intellectual performance was representative of their age. The subjects were selected solely on basis of their chronological age. The obtained variability in the 4-year-old's representations could therefore be due, at least partly, to individual differences, rather than to media or task effects.

Despite these weaknesses, these results suggest that there might be a common semiotic function for representation. There is a parallel in the results in different representation modes, and the general development sequence is virtually identical as well.

In terms of operative and figurative aspects of cognition this means that the underlying form (the operative aspect) at different ages is constant across the different representation modes (cf. Furth, 1969, 1973, 1986; Gardner, 1977, 1979; Sternberg, 1984). The differences found in the present studies have to do with the figurative aspect of representation, which according to Furth (1973, 1986), Gardner (1977), and Kelly et al. (1984) is bound to representation media and can vary as a function of media, task demands and individual differences. Since the
operative aspect of representation is according to Piaget (1973), the essential aspect of his theory, and consequently of the semiotic function, the variability in figurative knowledge (found in the present results) is not sufficient to reject the hypothesis of the semiotic function.

However, how the semiotic function actually is constituted, i.e. how the figurative and operative aspects interact in detail, and how the function exactly develops cannot be concluded from the present findings. Neither do we know how the task demands and the representation media interact with the different manifestations of the semiotic function. So far there has been no research that has clarified these problems. To investigate the problem area is an important next step for future research.

A serious problem of empirical kind is the fact that the different manifestations of the semiotic function are hard, if not impossible, to separate of each other. For example, both the experimenter and the children are generally using language (giving instructions or commenting the representation process), thereby compounding language with the other forms of the semiotic function. These difficulties are hard to solve and call in question whether the hypothesis of the semiotic function is testable at all.

Problems with representation media and task demands

The overriding problem in the present studies has been the role of the representation media, and in connection to this also the task demands. Representation media and task demands have caused problems also for other researchers. Since these problems are common both for us and others, the empirical research in this area will be summarized and discussed. This will be done under three headings: (1) The medium-specific hypothesis, (2) The task demands, and (3) Décalage.
The medium-specific hypothesis
Arnheim (1954) and Gombrich (1960), both investigating the graphic representation, have offered a medium-specific hypothesis for understanding children's representations in drawing. Both authors define the process of graphic representation as a search for equivalences of form in a given medium. From this vantage point the child's representations are seen as the early efforts of an inexperienced person who explores the graphic medium until he invents adequate forms which represent the objects to be represented.

Both Arnheim and Gombrich are convinced that drawing is a skill in a medium, which develops within the medium, and according to the conditions imposed by the medium. Both researchers have also questioned the adequacy of the intellectualistic interpretation (the one proposed by Piaget), and they reject the notion of one common underlying function for representation.

David Olson (1970) takes a perspective similar to Arnheim and Gombrich. He proposes that intelligence is skill in a medium, more specifically, skill in a cultural medium. According to Olson, a medium should be thought of as offering a range of performatory activities, each of which demands certain perceptual information. In studying children's use of symbols, Olson argues that one should enumerate the options confronting the child in a given task, within a given medium, and examine the child's way of selecting among these options.

In line with Arnheim and Gombrich, Olson then argues that it is in the context of preformatory attempts in a medium that the medium-specific abilities evolve. Furthermore, he suggests that psychologists should abandon the whole idea of general cognitive capacities underlying all media. In
order to understand the child's representation, they should concentrate on the specific demands and problems of each medium.

Salomon (1978) argues that different representation media require different amounts of mental elaboration. There are, according to him, not one medium which is easier than another per se. Rather it is because one medium, compared with another, can present information in better correspondence to the mode of internal representation which a person can best utilize. Seidman and Beilin (1984) suggest that symbolic performance is closely linked to the children's experience in the use of a medium.

Task demands
Clarie Golomb (1973, 1974) has pointed out the interaction between the child's cognitive level, the representation media and the task demands. She has studied the evolution of representation in children in different media and with different test-tasks. The media investigated were drawing, modeling with playdough and constructions with ready-made forms. The test-tasks varied along three major dimensions: degree of definition of task, forms provided or to be created by the child, and use of the medium.

Golomb found that the child's representation did not directly, or exclusively, reflect his conceptual development, but that there were clear differences in the child's representations across media, and across tasks within a given medium.

A study which neatly illustrates the role of task demands in children's drawing, is a study conducted by Barrett and Light (1976). Barrett and Light found that in attempting to classify children's drawings either as being intellectually realistic (according to Piaget's theory) or as being visually realistic (according to Arnheim and Gombrich), the classification of any given drawing may vary as a function of the classification scheme adopted by a specific
researcher. Barrett and Light could also find that the children did sometimes maintain a degree of consistency in their drawing styles across different drawings, but that this consistency was found only in those instances where the task demands - imposed on the child in the drawing situation - showed to be of equal difficulty.

On the basis of their findings Barrett and Light suggested, that what is required is not merely an analysis of drawing in terms of general stages of development (such as those postulated by Luquet (1927) and Piaget), but also an analysis of drawing in terms of task demands, involved in the producing process of particular graphic representations.

A model of children's drawing which is explicitly based upon the notion of task demands has been proposed by Freeman (1977, 1980a, 1980b). Freeman argued that the child's production of a drawing is always affected by the varying task demands which continuously confront the child throughout the drawing process. When a child is asked to produce a spontaneous drawing he has initially a lot of freedom to choose both the motive for his drawing, and the manner according to which to proceed in his drawing process. However, during his drawing process he has, according to Freeman, continuously to encounter different cues and demands which influence his drawing process in various ways.

According to Freeman, spontaneous drawings might not reveal the full extent of the child's graphic abilities, as they might not provide the child with the appropriate cues. The implication of the cue-dependency model of Freeman therefore suggests that an examination of the spontaneous drawings of children might well be an insufficient index of children's developing graphic abilities. Instead, it would seem necessary to adopt an experimental methodology for the study of children's drawings, so that the cues that are made available in the drawing situation can be
systematically manipulated. However, this does not mean that the development stages of Luquet and Piaget, have to be abandoned. According to the framework of Freeman these stages are viewed as generalized descriptions of collections of phenomena, which themselves need to be examined in terms of task demands.

Finally, a "mixed-media"-hypothesis was offered by Gardner (1982b), LeCron Foster and Brandes (1980), and Oppenheimer and Strauss (1975). These researchers have investigated the development of children's representation in different representation modes.

Oppenheimer and Strauss (1975) (comparing drawing, mental imagery and language) found, that representation in different representation modes develop at different rates, that there are different levels of difficulty for different tasks, and that there is a structural décalage, i.e. a time lag in the appearance of related cognitive processes across different tasks.

LeCron Foster and Brandes (1980), studying the course of symbolization in two different media - three dimensional construction and symbolic play - could discover that there are both universal patterns of symbolic growth and considerable individual variations in how these patterns are realized. The conclusions above are shared also by Gardner (1982b). Beyond that Gardner could also show that representation media appeared to correlate with the child's gender. Girls were likely to excel with mixed media (blending gesture, narration and three-dimensional forms in symbolic play), while boys were more likely to excel with single medium tasks.

Considering representation media and task demands, the views hold seem to be caught between two somewhat opposing positions. The specific-medium position, taken by Arnheim (1954), Gombrich (1960), Olson (1970), Salomon (1978), and
Seidman and Beilin (1984) downplays general understanding and highlights the mastering of the principles involved in using various media.

The mixed-medium position, represented in the present context by Barrett and Light (1976), Freeman (1977, 1980a, 1980b), Gardner (1982b), Golomb (1973, 1974), LeCron and Brandes (1980), and conceptualized by Oppenheimer and Strauss (1975) states, that both a general level of understanding and acquaintance with specific media and tasks are necessary for correct performance.

The position taken in the present thesis is similar to the one of Oppenheimer and Strauss. We agree with these researchers, that different representation modes develop at different rates, and that there are different levels of difficulty for different media and tasks. This position is closer to Piaget than the one of Golomb. Golomb refutes Piaget's notion of a single underlying function, although she agrees with Piaget about the development stages. Like Piaget we argue that there exists an unitary semiotic function. Unlike Piaget, however, we argue that there is an interaction between representation media, levels of difficulty of tasks, and individual differences in representations (cf. also Gardner, 1982b; LeCron & Brandes, 1980). This complex interaction is, in our opinion, not completely accounted for by Piaget.

Décalage

With regard to representation in different representation modes Piaget was very well aware that stages of thinking reached in one domain will not necessarily be found in the thinking of the same individual in another domain. However, stages for Piaget, only meant that there exists a lawful and logically consistent succession of one stage necessary before another.

In applying Piaget's thinking to the present context, it means that what is common in different representation modes
is the structural progression of activity within each particular representation mode, although it sometimes can occur at different times. This would be an example of what Piaget defines as horizontal décalâge, i.e. temporal discrepancies in the appearance of mental processes. As Piaget himself (Piaget & Inhelder, 1971) has put it:

At certain ages, the child is able to solve problems in quite specific areas. But if one changes to another material or to another situation, even with problems which seem to be closely related, lags of several months are noted and in some cases even of one or two years. (p. 10)

This type of décalâge explains (according to Piaget) how different media or different task demands can function as a limiting factor for the same thinking processes involved in the representation task in different representation modes or with different tasks.

The other type of décalâge, or temporal discrepancy, Piaget refers to is the vertical. Vertical décalâge refers to the employment of increasingly higher levels of logical structures. For example, a child at the preoperational stage might solve a problem using empirical representation rules (cf. study 2), which would be considered an indication of functioning at this special development stage. Later, at the concrete operational stage, he might apply formal rules to the solution of the same problem, which would indicate functioning at another, higher level.

The concept of décalâge can, in our opinion, be criticized for at least two reasons: for being too global, and for describing the issues included, rather than explaining them. A researcher who uses the décalâge concept somewhat uncritically, can indeed explain away all kind of empirically obtained differences.

In criticizing Piaget's use of the décalâge concept and his disregard of particular materials, tasks and representation media Gardner (1979) states:
At most Piaget is willing to concede a certain décalage across materials: still this "noise factor" is thought to be of minor significance in determining the developmental sequence in the domain under inquiry. (p. 76)

There is no need to be as critical as Gardner. It would be proposed that the fact that individuals do not function at the same structural level across all tasks and media, constitutes a serious problem in studying representation in different representation modes (cf. Case, 1985). Perfect consistency in performance across representation modes, even with the same test-task, is therefore, in our opinion, an unreasonably stringent criterion for testing the hypothesis of a common semiotic function.

However, it can be argued that the distinction made in this thesis between the operative and the figurative aspects of knowledge bridges over (at least in a broad sense) the gaps between what are universal patterns of symbolic functioning, and how these patterns are realized in different media and task (Furth, 1969, 1973, 1986; Gardner, 1974, 1982b; Kelly et al., 1984).

As mentioned before, according to Furth, Gardner and Kelly and his collaborators, the operative aspect of knowledge has to do with the universal processes underlying all symbolic functioning. These processes structure representation in different cultures, and different representation modes, according to rules characteristic of the developmental stage of the child. Furthermore, to be able to use the operative knowledge in a significant way requires, according to Kelly et al. (1984), high level familiarity with the representation content.

In dealing with the construction of representation, one is, however, faced with the complex and baffling problem to understand how the same kind of structural principles can be realized in different representation media and with different tasks. A priori, it is likely that different
media - despite certain similarities - are not equally exploitable for the representation of the same kind of knowledge or experience. The medium specific problems have, in our opinion, mainly to do with the figurative aspect of representation (cf. Furth, 1974, 1986; Gardner, 1974; Sternberg, 1987).

The whole representation process rests then, as we view it, on the twin form-building processes, one directed towards the rule-governed construction process (the operative aspect), and the other directed towards the articulation of patterns in different representation media and task (the figurative aspect). The ways how these two aspects of cognition interact in detail have yet to be ascertained.

Piaget was not explicit about this issue. When certain tasks, which appeared to share the same logical structure (the operative aspect), were found to be passed at widely different age, Piaget referred to this problem as the problem of horizontal décalage. In so doing he used the décalage concept in a way where the operative and the figurative aspects were compounded. However, as stated earlier, to study the hypothesis of the semiotic function both these aspects have to be investigated.

This matter is surely not an easy one. Both aspects of cognition are assumed to be functioning in all human adaptation. Operative knowledge involves an open development stage structure with two functional invariants, organization and adaptation (cf. Kelly et al., 1984). Figurative knowledge develops early (during the preoperational stage), and, unlike operative knowledge, it tends to be static and transmitted socially. These two forms of knowledge may dialectically interact, which makes it difficult to test the issue empirically.

Furthermore, in order to ascertain whether there exists one single semiotic function, cross-sectional studies might be supplemented with longitudinal ones. In cross-sectional
studies the décalâge problem could mask the developmental interdependence between tasks in different representation modes. In using longitudinal studies, the structural progression of stages becomes visible more easily. If it could be proved, that there is a similarity in the progression of stages in different representation modes, this fact can be used as valid evidence for the existence of the semiotic function, and also to validate the existing cross-sectional data.

Research in related areas of the semiotic function

Parallels between representations in different modes

When we started our empirical studies (several years ago) the subject of the semiotic function was totally unexplored. Since much of the recent research in this area was collected after the empirical studies were brought to an end, we will include some of the research in this part of the thesis.

In what follows, we will present the studies we found in this area. The research found is surely not exhaustive. There are, for example, fundamental differences between the types of tasks assigned to subjects participating in many (may be in all) of the studies. There are also individual differences (age, sex) between the subjects tested, as well as differences between the representation modes investigated. Some of the studies (Dillström Norgren, 1985; McCune-Nicolich, 1981) started out with the aim to investigate Piaget's hypothesis of the semiotic function, others (Greenfield, 1978; Smolak & Levine, 1984; Veereken, 1961) have only applied Piaget's theoretical perspective to account for the development of behaviours in different representation modes. Still others (Pellegrini, 1980; Wolfgang, 1974) are studying the parallel development of two representation modes without any deeper
theoretical concern. With these cautions in mind let us consider the findings in related areas of the semiotic function.

Dillström Norgren (1985) studied the development of graphic and verbal representational abilities in children aged 5 to 12 years. The purpose of her studies was to investigate the development of the semiotic function. Her results demonstrated that children's graphic and verbal representations, to a large extent, show similar structural characteristics for children at the same operational level. Her findings, thus, gave support to Piaget's theory of the semiotic function. However, it was also found that the impact from the media cannot totally be neglected.

McCune-Nicolich (1981) presented a theoretical analysis proposing concurrent developments in symbolic play and language, as aspects of the semiotic function, and evidence for certain correspondences. According to her the development of both symbolic play and language is in accordance with Piaget's theory, following a developmental sequence from juxtaposed elements to rule based hierarchical, symbolic combinations.

Smolak and Levine (1984) studied the relationship between symbolic play and language in children aged 1-3 years. On the basis of the McCune-Nicolich (1981) methodical systematization, the researchers provided some equivocal support for Piaget's contention. However, Levine and Smolak emphasized that there are several methodological difficulties to overcome. First, operational definitions of symbolic play and language may be problematic. Second, cross-sectional data, by their nature, can not identify temporal sequences in different representation forms (symbolic play and language). According to these researchers longitudinal data are required for studying the development of the semiotic function.
Results of several correlational studies have supported a general relationship between symbolic play and language (Fein, 1975; Fisher, 1980; Lowe & Costello, 1976; McCune-Nicolich, 1981). However, correlational analysis are considered to be too global to identify more specific relationships between the two different representation modes (cf. Fisher, 1980; McCune-Nicolich, 1981).

First, correlational analysis would be a particulary poor tool if there is considerable décalage in the appearance of various forms of mental representation. Second, correlations treat the dependent variables as a continuum, and this is an assumption which is incompatible with Piaget's argument of discontinuity in cognitive development. Consequently, correlational studies might well underestimate and distort the relationship that can be found if one makes a level-by-level comparison.

Veereken (1961) has applied Piaget's theoretical perspective to account for the development of complex constructive behaviours in drawing, blockbuilding and copying spatial arrays in children. Veereken could show that the same pattern of development in strategies emerges in the different spatial representations. His results and interpretations were consonant with Piaget's theory, relating the development of structures in different representation modes to an underlying cognitive organization.

In a series of studies Greenfield (1978) investigated the structural parallels between language and action (different construction tasks) in children. The basic questions investigated were: Are there organizing principles underlying linguistic functioning which also underlie cognition in other representation modes? If so, what are they? On basis of her findings she concluded that the two domains investigated were governed in their function and development by the same organizational principles. However,
these structural principles were not originating in either representation mode, but had their origin in a common underlying function. Consequently, she could find both media effects and décalage in her results. Her conclusion was, that as far as task demands vary among representation modes and media, the rate and timing of development in one would not necessarily be the same as in another. Nevertheless, her findings and interpretations support Piaget's theory of an unitary semiotic function.

In summarizing the findings above it can be concluded that children's representational ability in different representation modes seem to be dependent on a underlying cognitive function for representation. So far the findings support Piaget's hypothesis of the semiotic function.

However, similar media effects found in our studies and discussed under the heading Media problems and task demands were also found in several of these studies (Dillström Norgren, 1985; Greenfield, 1978). The conclusion made by these researchers was, that although representation in different modes and media may rest on the same organizational principles, specific parallels across modes and media, should not be expected or predicted. This conclusion is similar to the one arrived here.

Another question to be answered is: If there is one common semiotic function for representation, then it could be predicted that training of one of its manifestations would facilitate the performance of another. With this question in mind we reviewed some research, however it was not carried out with the same hypothesis as the present one.

Smilansky (1968) studied Israeli children of different socioeconomic background. She could show that children from low socioeconomic backgrounds used less developed verbal skills in symbolic play than their middle-class peers. However, she could also demonstrate that training in symbolic play improved the verbal communication of
children, indicating that there is a positive relationship between language and symbolic play. Similar results from United States have been obtained by Lowinger (1974), and Saltz and Johnson (1974).

Wolfgang (1974) has explored the relationship between selected aspects of symbolic play and reading in first-grade males. The results demonstrated that those first-grade males who had not achieved high levels of symbolic play had difficulty in reading as well as in other areas involving the use and manipulation of symbols and signs.

Pellegrini (1980) has examined the relationship between play and preschool children's later achievement in reading and writing. The obtained results indicated a significant relationship between symbolic play and literacy. It could also be demonstrated that preschool children who engaged primarily in symbolic play activities achieved significantly higher scores in comprehension of words and stories, and in understanding a variety of syntactic structures, than did children who experienced little symbolic play.

The conclusion of these findings is, that the training of one manifestation form of the semiotic function facilitates the performance of another form, indicating that these two forms are related, or (as Piaget claimed) originating from the same underlying function.

Taken together, the studies reported above seem to give support to Piaget's hypothesis of a single underlying semiotic function. Some of the studies point also to problems, similar to those found in our studies.

The distinction made by us - between the operative and figurative aspects of representation - was not found in any of these studies, although some of them (Dillström, 1985; Greenfield, 1978; Veereken, 1961) interpreted their data in terms of performance and underlying organizing principles.
We believe that the distinction made in this thesis would benefit future research in the area of the semiotic function, since this distinction is, in our opinion, important for understanding the differences in performances caused by décalàge, media and task.

**Cross-cultural invariance and variability**

Before rounding off the present thesis and drawing our general conclusions a remaining task will be to try out an additional hypothesis: If there is an universal semiotic function for symbolic representation, then children's representations in different cultures will show the same organizational principles (the operative aspect), but will vary with regard to content (the figurative aspect) (Furth, 1986; Kelly et al., 1984).

In order to examine this issue, we reviewed a number of recent cross-cultural research, with the basic intent to analyse it in those two respects. Two different domains were analysed: drawing and symbolic play (the two modes investigated also in our empirical studies).

**Drawing.** As a content area for analysing cultural variations, children's drawings are important for several reasons. First, drawing is an universal medium. Second, there are available standards that allow to make statements about what adults expect of children of various ages to produce. This enables us to make, at least gross comparisons among children's drawings from different cultures. Scientific norms from different ethnic groups by age and social class are, as far as we know, not yet developed.

With one exception (Harvey et al., 1986), none of the studies were carried out to test Piaget's theory.

The cross-cultural literature we analysed showed that the drawings differed in several dimensions - in cultural patterns and values, in size of the drawings, in the type
of affect displayed, in sex typing, in the use of a restricted as against an expansive style, etc (Alland, 1983; Fassler, 1986; Nuttall, 1988; Oliveiro, 1973; Rubenstein et al, 1987).

So far the differences were all differences in content, i.e. in the figurative respect. As far as the operative aspect was concerned, it was not explicitly investigated in those studies. However, none of the studies reported noticeable deviations from the general age norms. This indicates, however tentatively, a similarity across cultures with respect to the operative aspect of graphic representation.

Fassler (1986), for example, investigated children's (aged 4-12 years) drawings from China and the Soviet Union, and compared them with Western children's drawings. He could demonstrate that most of the children's drawings were consistent with expected levels of cognitive and conceptual development. However, Chinese children paid somewhat greater attention to detail than their Western counterparts of comparable age. This finding reflects, according to Fassler, a cultural influence, since drawing and handwriting are skills, stressed in Chinese schools at an early age.

As far as the content aspect is concerned, the drawings reflected the respective cultural and social values. For example, to limit further population growth, China is promoting the concept of the single-child family. Consequently, the Chinese children drew pictures of "a family" consisting of three persons - mother, father and child. Or, as in another study (Nuttall, 1988), the Chinese children incorporated also the extended family members (grandparents, aunts and cousins) in their drawings, in contrast to U.S. children who never drew an extended family.
Rubenstein, Feldman, Rubin and Noveck (1987) compared children's drawings in two different ideologies within a culture (Israeli children from nuclear families and from kibbutz), and in two different cultures (U.S. and Israeli town children). They could show distinct patterns in children's drawings, reflecting the different cultural ideologies both in male/female relationship, and in competition and individual achievement. The kibbutz children deemphasized competition and hierarchical relations in their drawings, compared with the other two groups. Beside these dissimilarities, the drawings of the three cultural groups were age-related, and thus in this respect comparable. Also these findings indicate that the cultural influence affects only the figurative aspect of knowledge.

Harvey and his collaborators (1986) studied 4-, 5- and 6-year-old Chinese and Canadian children's ability to draw graphic models. In contrast to the other here reported studies, their point of departure was Piaget's theory. In accordance with Piaget, they reasoned that two major influences of cognitive development - biological-maturational and social or enviromental experience - are interacting in ways not yet throughouly understood.

The investigators proposed that the sequential and cronological progression through the development stages should obtain across different cultures if biological-maturational factors play the more important role. On the other hand, similar sequential and cronological progression may not obtain across different cultural settings, if the cultural factors are more important. An interaction between the two key factors was considered to lead to an unfolding of the stages in an invariant sequence but at a variant rate (indicating a décalâge problem).

The results supported Piaget's theory. Spatial representations improved systematically and predictably as the Chinese and Canadian children got older, and the
similar patterns of responsivity and improvement found in the two cultural groups enhanced, thus, the Piagetian position. Similar findings were obtained earlier in another cross-cultural study by Hoffman and Trepanier (1982). The research of Harvey, and Hoffman and Trepanier reinforces our reasoning, indicating that the operative aspect of representation is invariant across cultures.

Symbolic play. Cross-cultural studies of children's play provide, as well as do the drawings, an insight into the values and socialization procedures of a society. The studies reported below were analysed with the same intent as was drawing, i.e. to study the interplay of operative and figurative aspect of representation.

In an ethnographic study of the Tallenesi people on African Gold Cost, Fortes (1976) made observations of children's play, emphasizing primarily the development phases of play. The author could conclude that although the play of the Tale children was influenced by the culture (with regard to the kind of objects used in play), the psychological processes underlying socialization remained unchanged. Also the developmental sequence was the same as Piaget described, developing from egocentric play at the preoperative stage, to socialized play at the concrete operational stage. In symbolic play even the themes of the play were similar to the ones observed in Western children. The 3-year-old Tale boys were "riding horses" using a long stick as a horse, and the 3-4-year-old girls were drawn into the family play of slightly older children, playing to cook meals and mothering children. The authors' observations are, thus, consonant with our expectations.

Children's play in Sri Lanka was compared with British preschool children by Prosser et al (1986). In this exploratory study the researchers observed the "free play" of 4-5-year-old children and categorized it according to a scheme used with British preoperative children. Their results showed, that although cultural factors determined
the content of the play, very few behaviours appeared to be culturally specific (3 behaviors out of 100). Most of the children in Sri Lanka engaged in a form of symbolic play similar to the Western children. Furthermore, the children without access to commercially produced toys played according to the same rules as the children who had access to this kind of toys.

The researchers concluded, that "any claim to have found a reliable way of subsuming play behaviour under readily recognizable universals must, of course, be tempered with caution" (p. 185). Nevertheless, they could show that the form of play was similar across the two cultures, and that the dissimilarities had to do with the particular content of play, which, in turn, was determined by cultural factors. Also Prosser's results are in accordance with our hypothesis.

The conclusions drawn from the cross-cultural research have to be very tentative. This is due to manyfold reasons. The studies reported are far from exhaustive. Further, they have been conducted with different purposes, often with non-random samples, with differing experimental designs or without any such design, with different ages of children and with language difficulties inherent in cross-cultural studies.

However, if we regard the cross-cultural research as a collection of observations of children's drawing and symbolic play, the gathered results can give us some hints about the universality and relativity of the representation modes in question.

Approaching the research inductively we can state: To start with, we have observed that cultural differences exist in the content of both the drawings and the symbolic play. On the other hand, we have also observed that neither the
drawings not the symbolic play behaviours do not deviate from the general age norms. On basis of this, it can be concluded that the cross-cultural research gives some support to our hypothesis (as far as these two representation modes are concerned), that the operative aspect of representation is universal, and the figurative aspect varies across cultures.

General conclusions and suggestions for future research

The main purpose of this thesis was to explore the question if there existed one single underlying semiotic function for representation in different representation modes. In order to do so, we examined the problem from both a theoretical and an empirical point of view. The conclusions drawn will therefore be based not only on our own empirical research, but also on theoretical considerations.

To begin with, we consider Piaget's hypothesis of the semiotic function as the best alternative to understand the development of representation in different representation modes. However, it remains only a hypothesis. A scientific theory implies a high degree of consistency, order and stability, and it has to be composed of a set of theoretical constructs, conceptually and/or operationally defined. The hypothesis of the semiotic function does not fulfil these expectations. Piaget never outlined how the different representation modes of the semiotic function are related exactly, or how they develop together. Neither did he explicitly delineate the relation between the biological bases of behaviour (which is commonly thought of as universal) and the individual, social and cultural conditions through which human activity takes place. The issues above are critical to any theory of development and have to be explored closer in further research.
The distinction made by us between the operative and the figurative aspect of representation can be considered as one attempt to narrow down the generality of the hypothesis of the semiotic function. The separation between the two aspects allows, in our opinion, to distinguish (at least in a broad sense) between what is expected to be universal about the semiotic function, and what is considered to be dependent on individual, social, or cultural differences.

Our empirical studies, each of which investigated different aspects of the semiotic function, supported on the whole Piaget's hypothesis of the semiotic function. However, this was so only when the distinction between the operative and the figurative aspect was brought out.

The operative aspect (investigated in study 2 and 4) was similar across the representation modes, supporting Piaget's hypothesis, although the defective parallel between the two studies may weaken this conclusion. The figurative aspect, on the other hand, showed some variability across representation modes in the younger age group (especially in study 1 and 3), indicating that the impact of representation media and task demands should be taken into account.

Problems with representation media and task demands, which became apparent in our studies, constitute an issue commonly known and often criticized in Piaget's research. Our conclusion is that problems with media and task affect the figurative aspect of representation, whereas décalâge can be found in the operative aspect. The concepts are often compounded and researchers report décalâge, media effects and task demands, not seldom, interchangeable or under the same heading - problems with media.

What is needed, then, is to explore this issue throughly. This should be a particularly exciting challenge for future research. Such an inquiry may provide powerful evidence about the relations underlying symbolic representation in
different representation modes, and contribute definitively to the developing theory of the semiotic function.

As it is now, we are left with several unanswered questions:

* Do different representation modes develop in parallel, or does the semiotic function come into play in different representation modes at different times?

* Does each representation medium have its own properties and limitations, inherent in the media, which makes comparisons across media difficult or maybe even impossible? Or is it so, that only time and experience is needed to make the individual able to create comparable products in different media?

* What are we in fact measuring when we change the task demands? Can we state that the cognitive processes underlying representation are the same when the child is given a vaguely defined task (for example a spontaneous drawing), compared with the case when he is presented with ready made forms? Or is it so, that the vaguely defined task reflects the truly operative aspect of the child's representation ability, whereas the construction of a task from ready-made forms mainly utilizes his figurative knowledge?

* How can we separate the different manifestations of the semiotic function and investigate them empirically? As it is now the five manifestations constitute a closed system with apparently now way out of the system.

These questions have to be investigated before any conclusive inferences about the semiotic function, the media and task can be made.

The parallel studies in related areas of the semiotic function also supported Piaget's idea of one common
underlying function. So did the cross-cultural research we analysed. As far as the latter is concerned, it supported tentatively our hypothesis of the universal operative aspect of the semiotic function, and the cross-culturally varying figurative aspect of the same function. But as stated before, it is a dubious strategy to draw inferences from studies that are conducted with different theoretical considerations than ours or with different purposes. Nonetheless, comparative statements are commonly made in terms of a guiding theory or a guiding hypothesis. We therefore dare to include the results obtained from these studies in our conclusions, and treat them as supporting our hypothesis.

In summing up it can be stated, that the research reported and discussed in this thesis reinforces, on the whole, Piaget's overall picture of the semiotic function. It highlights the universal underlying organizational principles used in representation, and it reveals the differences in terms of media, task and culture.

The complex research area concerning the semiotic function is, nevertheless, still waiting for future research. Clearly such a task will call for efforts of the range and perspective of those undertaken by Piaget himself. Of particular importance will be the delineation of the interplay of the operative and the figurative knowledge in representation. Another issue that needs to be undertaken concerns the role of representation media and task demands.

As it is now, a tension is created between the concepts at issue. A number of researchers are strictly following Piaget's basic assumptions, that the different representation modes are developing in a similar fashion and in close parallel. Another number of researchers have focused on specific media and task demands, and abandoned the whole idea of a unitary underlying function for representation.
A direct comparison of these competing views would reinforce the whole issue, and bring together the different research findings. These findings would then contribute to the growing awareness of the centrality of a fundamental human capacity of symbol use, and point to the importance of detailing its development in different modes, media and cultures. The time to treat this issue seems at hand.

Finally, the cognitive view of symbolic functioning, taken in this thesis, cannot be split off from the emotional and social aspects of development. The prerequisites for symbol use are rooted in the affective as well as the cognitive sphere. The motivation to symbolize, and the content of what is symbolized, cannot be fully understood when the affective realm is left out. This, also, is an issue for future research.


