Thought Without Language

Edited by

L. Weiskrantz

A Fyssen Foundation Symposium

CLARENDON PRESS · OXFORD
1988

2

The ontogenesis of different types of thought: language and motor behaviours as non-specific manifestations

PIERRE MOUNOUD

A symposium on the topic 'thought without language' should enable us to take stock of the present state of knowledge of a very complex problem which has intrigued scientists and philosophers for centuries and which, after a surge of interest at the beginning of this century, has now re-emerged as a topical issue, thanks particularly to recent developments in neuropsychology. Rather than to simply review the data on non-language-related behaviour, however, it would be more fruitful to make a general statement on different types of thought and, more specifically, to speculate upon what exactly thought with or without language might be.

To begin with, I will attempt to show that the first stages of language development are not different from those of the development of thought, contrary to Vygotsky's opinion, for one. Indeed, I believe that the manner in which a baby succeeds in knowing or in appropriating the complex object of language is the same as that in which he knows or appropriates any other object around him, including other people and even his own body. I will then try to demonstrate that the same is true for later stages of development. This approach leads us to the conclusion that we should substitute for the dichotomy of verbal and non-verbal thought a comparison of the different *types* of thought which characterize the phases of the construction of knowledge, including language.

At the beginning of this century, this symposium might have been called 'intelligence without language'; at the end of this century, 'cognition without language'! I admit that I am still not sure why the organizers chose to formulate the problem in terms of 'thought'. It may have been due to a certain weariness generated by the endless debates over the concept of intelligence—or it may represent a kind of challenge. At a time when many theories attempt to explain complex behaviour as consisting of properties emerging from the interaction of elementary systems (see, for example, Kugler *et al.* 1982), the choice of the term 'thought' seems indeed provocative. In spite of the

difficulties involved in defining thought (or intelligence), there have been numerous efforts throughout this century to characterize its different forms in terms of simple dichotomies. Thought without language refers to one of these oppositions and gives reason to suppose that it is somehow distinct from thought with language.

The opposition between thought with or without language has a direct relationship to the opposition between practical and conceptual (or representative) intelligence (Köhler, Guillaume, Meyerson, Piaget, Wallon, etc.). This dichotomy, classical at the beginning of the century, is still alive under different labels such as non- or pre-symbolic thought vs. symbolic thought. The contrast that Piaget (1978) set up between 'success' and 'understanding' can be considered as a reformulation of the same question. Piaget's distinction is based upon the idea that our behaviour is guided by two different types of goals, one being direct adaptation to reality, i.e. the search for immediate success, and the other being more disinterestedly dedicated to knowledge as such, independent of any pragmatic motivations. Twenty years ago in my doctoral thesis on the child's construction of simple tools (Mounoud 1970), I criticized the dichotomy between practical and representative intelligence as a single chronological transition. At that time I considered it to have little relation to the absence or presence of language. I claimed, however, that, in contrast to conventional theory, at any stage of cognitive development there is a passage from a type of intelligence that can be described as practical to a representative or conceptual type—even during the sensori-motor stage.

To better understand this problem, I would like to briefly mention some of the dichotomies used by Piaget to characterize successive types of intelligence. First, Piaget (1952) divided the sensori-motor stage into six substages, defining three successive types of intelligence, respectively called 'practical', 'subjective', and 'objective'. When, later, he studied the concrete operational stage (for example, Piaget and Inhelder 1948), the third type of sensori-motor intelligence called 'objective' was renamed 'practical' in order to reconstitute the same relationship (practical vs. conceptual) at this stage. Finally, when he defined the stage of formal operations, he refocused on the opposition between concrete and formal (Inhelder and Piaget 1955). These shifts in terminology (from objective to practical, from conceptual to concrete) to characterize a single type of intelligence illustrate a major problem in developmental psychology: how to establish global comparisons between stages in terms of *types* of intelligence. As I will further discuss later on, I prefer to use these terms to qualify phases in a given stage (or the transformations in a given stage) as Piaget did for the sensori-motor stage rather than to differentiate between the stages themselves.

A few other oppositions along the same line are worth mentioning, such as the one between intuitive and rational thought, which was used extensively at

the beginning of the century, by, for example, Piaget. This dichotomy has been taken up again, probably due to its similarity to the more recently introduced opposition between wholistic and analytic thought or between implicit and explicit knowledge. One criterion that has been used to compare these different types of thought concerns the goals attributed to them, including such goals as the necessity of immediate adaptation and the need to understand, know, and explain. A second criterion refers to the way they function: intuitive thought and thought without language are supposed to function 'wholistically', apply to bounded, unspecified elements of a given situation, use success and failure as criteria, and be basically data driven. Rational thought or thought with language, on the other hand, is supposed to function analytically, apply to unbounded, specified elements of a given situation, use truth and falsity as criteria, search for proof, and be basically conceptually driven. What seems clear to me is the complementarity of these various types of thought. The major problem is to understand their mutual and necessary relationship and their interdependency.

Human subjects are simultaneously oriented to different goals such as adaptation and understanding; moreover, in ontogenesis, there is no choice between these alternatives. Both understanding and adaptation are necessities tied by nature to each individual and in particular to our species as a whole. It is usually considered that through phylogeny humans are becoming able to escape, at least partially, the need for direct adaptation and satisfaction of needs in order to be able to engage in reflective activities (or thought!) that are supposed to give them access to the understanding of 'the possible'—origin of our hypothetical freedom!

A developmental framework

Let us now take a look at our conception of knowledge or thought construction. First of all, I consider cognitive development to be defined by a general process which is shared by all areas of knowledge, as opposed to the line of reasoning which postulates that there are specific processes for each domain of knowledge. Of course, in this view, the existence of a general process would not exclude specific underlying mechanisms. Second, I think that this general process is repeated several times during the course of development, and that the main developmental stages are thus defined. This general process can be defined as a process of thematizing (or of conceptualization) of the transactions that an organism has with his environment (physical, social, linguistic, etc.). It is related to what has been called 'objectivation', 'explicitation', 'awareness', or 'abstraction'. However, this process is not limited to simply rendering explicit or expressible or understandable that which has been experienced or expressed automatically: it is

not only a question here of a process of meta-cognition where behaviours first *experienced* on one level of consciousness are then *conceptualized* on another level.

There are several reasons why the process of thematizing cannot be reduced to a simple grasp of consciousness. First and most important, there is a *qualitative transformation* of behaviour throughout the course of development. Between the new-born's automatic stepping and the voluntary walking of the one-year-old child, there is not only the simple addition of awareness. The same is true for the infant's early 'prehension' (reaching and grasping) and the one-year-old's 'late' prehension. There is, in these cases, a complete reorganization of the mode of interaction with the environment. We can make the same observation at other stages of development—such as, for example, the evolution of seriation or of classification skills in the three-year-old and in the 10-year-old (Mounoud 1986).

The second reason is that the phenomenon of *awareness is a transitory phenomenon*. It is true that during the course of his development the child analyses or becomes conscious of certain characteristics of his actions and of the objects he acts upon (as, for example, in the case of learning to walk, speak, write, etc.). It is also true that by the time the ability has been mastered to a certain degree, this consciousness disappears; we are unaware of or develop misconceptions about the rules governing our own behaviour (consider, for example, the grammatical rules of one's mother tongue).

The third reason is that of *progress*. While it may be commonly accepted that the child's development consists of steady improvements, we are far less certain when we consider the complexity of the *preceding* forms of knowledge. What is more, progress is sometimes accompanied by regression or even by a loss of competence. A case in point is the loss at the age of one year of the ability to discriminate between contrasting phonemes which do not exist in the baby's native language (Werker and Tees 1983). This may be due to an attentional deficit as Jusczyk (1985) has suggested. I believe, in fact, that all development and all transformations of knowledge take place within a context which we will call 'loss and gain'. The gains acquired in the accrued ability to plan and to control time and space compensate for losses in other areas (for example, neglecting dimensions previously taken into consideration).

It seems, therefore, that at each level of development, the child's behaviour illustrates a general process of thematizing (or conceptualization) which concerns not only the properties of objects but also the characteristics of his own actions. This process is at the origin of what is ususally called new forms of behaviour and which includes language. Our position is that this process depends on the child's capacities of symbolization (which includes both analogic representation usually qualified as non- or pre-symbolic and abstract or symbolic representation), and that several times in the course of

development new symbolic capacities emerge (at birth, around age two, around age 10). We call capacity of symbolization the ability to translate or to transpose by means of a new coding system the current experiences of the organism which are initially determined by a different system of representation. In this perspective it is not possible to speak of thought without symbolization, language being just one of its expressions. The general process of thematizing is a complex one which involves several phases. Throughout these phases, it is possible to determine different types of thought, which is to say, different levels of knowledge and understanding or of planning and control.

The elaboration of new representations necessitates a new demarcation, a new segmentation—a new decomposition of information. The subject must therefore redefine the actions he produces and the objects with which he interacts, including his own body. In other words, he must carry out a new sampling of incoming and outgoing information in order to construct new representations. This translation seems to take place in two clearly distinct phases: the first one which we call semantic and during which the most important aspects would be semantic (or pragmatic), but also morphological, and a second phase called morphological during which the principal aspects would be morphological but also, of course, semantic.

These two phases consist of the translation, by means of a new code, of the different contents (objects, people, his own body) with which the child interacts from one level of representation to another. It is necessary to distinguish between several types of codes giving rise to representations on different levels. It is the appearance of new coding capacities, which I have suggested calling perceptual at birth, conceptual at around two years, and semiotic or formal at around 10 years, which determine the stages of cognitive development of the child. These new coding capacities constrain the child to reorganize, and to redetermine his behaviour (Mounoud 1981, 1983, 1985; Mounoud and Vinter 1981, 1985; Vinter 1985, 1987).

During the *first phase* of this process of thematizing (the first six to nine months for the sensori–motor stage), the objects and the subject's actions—given that they are initially determined by global representations (intersensori–motor coordinations)—are decomposed in terms of their components (segments, elements, organs), which will be defined and processed in the form of *elementary representations* (analogic). This first delimitation is pragmatic; that is, the components or segments taken into consideration consist of functional elementary units liable to have independent meanings. These different components or segments defined by elementary representations are at first isolated and juxtaposed with few relationships between them and few precise links to the configurations from which they have been abstracted and isolated. We can compare them to unbounded engrams (Harnad 1982). This first phase ends with the integration and co-ordination of the isolated

components into *total representations* (non-decomposable, non-analysable) or functional totalities (bounded engrams). This last episode is similar to the operation of 'reduction' mentioned by Bisiach (1988) and can be compared to perceptual grouping or cognitive chunking of meaningful units. The first phase illustrates the type of information processing that Fodor *et al.* (1984) have called 'synthesis by analysis strategy'.

During the *second phase*, these integrated whole configurations or functional totalities defined by total representations (perceptuo–motor patterns or bounded engrams) are analysed according to their morphology in relation to more abstract dimensions whose variations are progressively mastered. These dimensions are not defined independently of the totalities as is the case during the first phase, but rather in relation to them. In other terms, in this second phase the rigid functional totalities constructed during the first phase are analysed either according to the relationships among their parts (intra-object relationships) or to their interrelationships (based on one of their dimensions and its variations). This second phase corresponds to what Fodor *et al.* (1974) call the 'analysis by synthesis strategy'.

As far as the sensori–motor stage (or stage of perceptual representations) is concerned, I have already described in detail and on several occasions (Mounoud 1983, 1987; Mounoud and Vinter 1981; Mounoud and Hauert 1982; Vinter 1986, in press) the development of reaching, imitation, face perception, and self-image. Here, I will only very briefly illustrate the general process of thematizing, taking reaching as an example.

Examples from infancy

The development of reaching behaviour

To gain a better understanding of the development of reaching, it is necessary to take into consideration the behaviours manifested by the baby during the first weeks of life. Several authors (Bower *et al.* 1970*a*, 1970*b*; Trevarthen *et al.* 1975; von Hofsten 1982) have demonstrated that infants are capable, during the first days of life, of a kind of reaching, which is quite surprising; they are able to project their arms in the direction of a visually perceived moving object. The new-born's reaching behaviour manifests his capacity to process certain categories of information related to the situation and to his own actions. Most, if not all, of the components of the movements of reaching are present in the first behaviours of the new-born in a remarkably well-organized form (such as, for example, the opening of the hand during transport or the fingertip–thumb grasp). The co-ordinated activities of the head-arm-hand will progressively dissociate to become elementary activities. These are only partially co-ordinated. This dissociation seemingly enables the baby to identify different segments or components in relation to different functions

which they are apt to fulfil—hand opening and closing in relation to grasping or releasing an object; flexion and extension of the elbow according to the distance of the hand; wrist rotation based on different orientations and configurations of the hand; etc. (semantic or pragmatic phase). Correspondences can also be established between certain movements and their accompanying perceptions (for us, origin of the perceptual elementary representations). These elementary activities will then be progressively reintegrated, with the result that new globally organized reaching movements will appear (based on perceptual total representations). These movements are usually described as visually triggered, i.e. programmed before their execution, the hand opening during the course of the trajectory, closing again on the object. This brings us to the 24- to 32-week level which White *et al.* (1964) consider to represent the highest achievement, the 'top level' of reaching.

From this point, the 'late' reaching behaviour evolves (morphological phase); this involves more precise adjustments (the orientation of the arm; the opening and closing of the hand) based on the characteristics of the object to be seized (shape, size, weight, orientation). These adjustments will then lead to a complex reorganization of the activity of reaching as well as of its individual components. After 32 weeks, this non-decomposable, non-modulable collective activity constituting reaching gives rise to a complete reorganization which consists of controlling the different parts or units of this complex activity to adapt to the different conditions under which the activity is supposed to be able to be used. This second phase, which could be qualified as late evolution, has been remarkably described by Halverson (1931). In his study of the development of fine grasping, he maintains that at the age of 12 months the baby attains a level of prehension comparable to that of the adult, which has since been confirmed by more recent studies (von Hofsten and Rönnquist, in press). Adaptations to the reach as a function of different orientations of the object to be seized (Bushnell 1982; Lockman and Ashmead 1983; von Hofsten and Rönnquist, in press), as well as adaptations to the grasp as a function of the weights of objects (Mounoud 1973; Mounoud and Bower 1974), are other examples of the second level of organization beginning at around six to nine months and ending at around 16 months.

I have briefly summarized the evolution of reaching because it is among the domains I have studied in detail. Now we must examine the development of speech production in order to establish to what degree it is comparable to the process I have just described. Unfortunately, the complexity of this field, the limitations of our own knowledge, and the restrictions of space will confine us to a rather schematic discussion.

Early speech production

It is well known that around the age of one year the baby produces his first

words, entering the phase known as the 'one-word period' which lasts around seven or eight months, that is, until about 18 months (see Dromi (1986) for a review of the question). This period has also been called the 'holophrase stage' by McNeill (1970). For McNeill these single-word utterances correspond to complete adult sentences, which has since been contested by numerous authors. This period is succeeded by the period of word combination productions or sentence construction (McShane 1980), which begins with the production of two-element utterances (Gregoire 1937; Braine 1963). The appearance of single words corresponds to the acquisition of lexical referential meanings (in other words, the constitution of symbols); that is to say, the possibility of relating meaning to defined sound sequences.

I take the position that the emergence of words represents the formation of totalities which are initially non-decomposable. This interpretation is akin to Studdert-Kennedy's (1986). For him, words are perceived as sequential and co-ordinated articulatory gestures and can be reproduced without considering the baby as having a concept of phonemic relationships or an articulated programme in which individual segments are concatenated. In the child's first word productions, Ferguson (1986) has demonstrated that it is the word which is the contrasted unit and not the phonetic segments.

This outcome may seem contradictory to the experimental data which show that quite early the baby is sensitive to the internal structure of words, at the level of phonetic segments (MacKain 1987; Mehler 1983). It is also known that just at the moment when the first words appear, the baby's discriminatory capacity diminishes in terms of its sensitivity to phonemic contrasts which are not from his native language (Werker and Tees 1983). In addition, as Jusczyk (1985) notes, several studies on phonetic perception (Edwards 1974; Garnica 1973; Shvachkin 1973) suggest that 'the one-year-old child is often unable to make many phonemic distinctions that appear to be well within the limits of the perceptual capacities of the average 2 month old' (p. 223).

In the model presented here, however, the phase which precedes the emergence of the non-decomposable totalities (in this case, words) is concerned with the elaboration of the components or elementary segments. From this point of view, the fact that words are not decomposable is not in contradiction to the baby's anterior production of components or segments smaller than the word. Contrary to what Studdert-Kennedy (1986) maintains, development does not always proceed from a level of undifferentiation to one of differentiation, or on the basis of 'analysis by synthesis strategy'.

During the period defined by the production of single words, babies seem to be actively involved in the improvement of the form of the words they produce. The initial productions are often only approximations, and, to succeed, the baby must modify certain parts of the totalities. During the one-word period, the transformations within the word forms recorded by Dromi

(1986) revolve around phonological changes, such as the addition of previously omitted phonemes, the modification of consonants and/or vowels, and the substitution of an appropriate phoneme for a distorted one, as well as around morphological markings, including inflections of number, gender and diminutives of nouns, and number, gender, and tenses of verbs. Dromi insists on the fact that phonological and morphological processes are highly correlated and may function in similar ways when adapted by the child for shaping his own production. According to the interpretation here, these transformations show that the baby is involved in an analysis or in a decomposition of the totalities which Menyuk and Menn (1979) call analysis of meaningful units. These analyses are thought to be carried out first on the basis of syllable-sized units, defined by their position in the word, and only later on the basis of phonetic segments (Menyuk and Menn 1979; Bever 1982). In addition, according to Mehler (1983), 'the response to phonetics or to distinctive features appears after access to lexicon when words are understood in and of themselves' (p. 141).

The description of the stage preceding the one-word period is certainly more difficult, and, what is more, most of the experimental data are inconclusive, especially concerning speech perception. One must also keep in mind, as Menyuk and Menn (1979) note, that the phonemic productions of the pre-speech period have not been seriously taken into consideration by linguists.

Let us finally take a look at the development of pre-speech vocal productions. By the age of three months, the baby begins to imitate and produce language sounds. According to Stark (1979), cooing sounds have often been described as vowel-like. In fact, they contain brief consonant elements. The sounds produced by the baby can be described as 'syllabic nasalized vowels' or as 'syllabic nasal consonants'. When cooing sounds first emerge they are produced as single segments. Subsequently, these segments are produced in series. This is an example of what Zlatin (1975) has called '*early syllabification*'. The productions described as 'vocal play' also first appear as single segments in which babies prolong vowel- or consonant-like steady states, slowing down the rate of change. These vocal play segments are also produced later on in long series. From about six months on, the baby produces *reduplicated babbling*, defined as the production of series of consonant-vowel syllables in which the consonant is always the same. The syllable duration and that of the consonant-vowel syllables are close to adult speech. Nevertheless, precise temporal control still has not been achieved. Beginning at around nine months, *non-reduplicated babbling* emerges in which vowel-consonant-vowel and even consonant-vowel-consonant syllables appear. In short, it is possible to say that between the ages of three to 12 months, the baby produces isolated, juxtaposed, and reduplicated elementary segments, which are progressively better shaped, better controlled, and more complex.

Based on the experimental data cited here, I propose the following periods to characterize speech-processing. At birth, there is a global organization of speech-related activities (which I consider to be based on preformed representations). This global organization would be responsible for, among other things, temporal synchrony between the baby's lip (pre-speech) and arm movements and adult speech, prefiguring speech activity (Trevarthen 1979). Intersensori–motor co-ordination also allows the baby to localize sounds. This organization would also account for the discriminative ability of the newborn relative to auditory speech contrast.

During his first year, the baby elaborates (in addition to prosodic and suprasegmental aspects of speech, cf. Crystal 1979) *elementary segments or components* of a syllabic nature (isolated or juxtaposed or reduplicated), which come from a new perceptual encoding leading to elementary representations. These could be compared to the interpretative schemas as defined by Jusczyk (1985). These elementary representations which result from the perceptual encoding of visuo–auditory and proprioceptive information allow the baby to produce specific articulatory patterns at the syllabic level. Thus, at around one year, there is a co-ordination or integration of these segments or components which gives rise to words as *non-decomposable totalities*. Then, these totalities become decomposable, first into syllabic units defined by their relative positions in the word, and then into more abstract phonemic units. And finally, as Jusczyk (1985) notes, 'the process of building up a set of prototypical spectral representations commences ... Building up such a dictionary is apt to be a long and arduous process' (pp. 219, 223).

Even if the present interpretation might be seen as stemming from a 'fortuitous realism' (one of the kinds of pre-causality described by Piaget), I consider the similarities between speech development and that of other types of behaviour, such as reaching, to be so close as to allow us to infer a general underlying process of construction. I have yet to consider what is for me the most striking aspect of the ontogenesis of behaviour in children: the repetition of this general process throughout the course of development. I will therefore briefly examine the 4- to 8-year-old child's capacity to analyse and segment words. And, finally, I will compare his progression in this area to his ability to construct simple tools. Once again, I will try to demonstrate the non-specificity of language development.

Examples from childhood

Word segmentation and learning to read

As far as learning to read is concerned, the question of readiness to learn was reformulated in an interesting way by Liberman and his colleagues (Liberman *et al.* 1974, 1977; Shankweiler and Liberman 1976), and was taken up again

and developed by Alegria, Morais, and Content (Alegria and Morais 1979; Morais *et al.* 1987), among others.

According to Alegria and Morais (1979), learning to read within an alphabet system presupposes the capacity for explicit analysis (or segmentation) of speech in terms of phonemes. Now this capacity appears in the child at around 6 years of age. It increases rapidly at the onset of reading instruction and seems to be an important 'accelerator' of the ability to read. It is present in a small percentage (17) of 6-year-olds after three months of primary schooling, but reaches a high percentage (70) by the beginning of the second year of primary school. The authors think that instruction in reading or schooling has a 'net accelerator effect' on the capacity for phonemic segmentation.

Nevertheless, activities of segmenting or fractioning speech are carried out by children younger than 6 years, especially syllabic segmentation which is achieved by 46 per cent of 4-year-olds (4:10) (Liberman *et al.* 1974). Therefore, we are not dealing with a general impossibility for children under 6 years to fragment or decompose an auditorily (or visually) perceived continuum from a temporal (or spatial) point of view. These capacities for syllabic segmentation would explain why Japanese children learn, without systematic instruction, to read the 'katakana' before entering school (Sakamoto and Makita, 1973). It would also explain how Rozin and Gleitman (1977) managed to teach children who experienced difficulties with the alphabet to read syllabic writing without any notable effects on their capacity to read with the alphabetic system.

Syllabic segmentation seems to us to be possible because it is based upon units (elements or segments) which can have a reality of their own and may sometimes have their own meanings for the child, independent of the totalities into which they may be placed. In contrast, *phonemic segmentation* is based on 'units', which have been described as 'abstract' or 'formal', and which have no existence or meaning independent of the whole of which they are a part, as we have already pointed out. They can only result from breaking this totality into parts and have no existence outside these totalities. Expressed differently, *the phoneme* would only exist as a 'part' of a (bounded) whole and would not be accessible to 3-, 4-, or 5-year-olds at the conceptual level, whereas the syllable could exist on its own, independent of any larger entity which might include it as a segment. This does not mean, however, that *the syllable* has the same status when it is identified as an isolated entity as compared to when it is a part of a whole. These distinctions are, of course, only relative and correspond to what may be considered the subject's point of view at different steps in development. Liberman has shown that children can break words into syllables from the age of 4, while a more recent study by Bellefroid and de Ferreiro (1979) shows that the syllable becomes a 'part' of a word (with a defined position with respect to other parts) from the age of 6 years. As a part

of a word, the syllable is thus 'defined with respect to the ensemble of word parts' by its relative position. Thus, during development, the syllable can have two fundamentally different statuses: (a) before 6 years it would have the status of an 'independent unit' (inseparable from meaning) which can be regrouped or juxtaposed with other syllables; (b) after 6 years it would have the status of 'part of a word', but essentially defined in terms of its relative position.

Using an example borrowed from psycholinguists, I have tried to show how the transformation of word segmentation capacities during learning to read at the stage of conceptual representations can now be explained by the general process of thematizing previously described and illustrated by early speech production at the stage of perceptual representations.

The existence of different systems of graphic transcription of languages (ideographic and phonographic) offers a supplementary demonstration that processes related to language (including written language) are expressions of a more general process. The ideographic system is related more to the first phase of the general process described as a first type of thought ('synthesis by semantical analysis strategy'), whereas the phonological system is closer to the second phase, considered to be a second type of thought ('morphological analyses by synthesis strategy'). This is one of the most convincing pieces of evidence that language-related phenomena are non-specific to language.

I would now like to briefly show how the general process manifests itself in relation to the way the child is able to define simple objects, such as tools, in problem-solving situations. This example will also allow me to demonstrate the capacity for integrating elements into a whole (the corollary of the capacity to segment).

The construction of tools

The general process of thematizing which describes the passage from a pragmatic or concrete organization to one which is formal or abstract can be illustrated by the results of some research carried out on the construction of simple tools by 4- to 8-year-old children (Mounoud 1970). In these studies, two radically different levels of analysis and problem-solving were demonstrated. These two levels seem to bear a close correspondence to the two phases of the general process.

A primary 'level' of analysing problem situations and of defining tools, typical of 4- and 5-year-old children, is based on a decomposition of the problem into tasks or elementary actions/properties; for example, in tasks involving reaching, reaching around, pushing, and seizing. These actions are used to define or to qualify different segments or pieces of a tool. Each segment thus has its own property: reaching, reaching around, pushing, taking, grasping, hooking, etc. This kind of segmentation can easily be called pragmatic or semantic.

At the 'second level', tools are defined by a general function or by a global transformation progressively specified by the relationships between different parts of the tool and of the situation. These parts only have meaning in relation to the whole (bounded whole), and the relationships are elaborated in reference to the signification of the entire tool. An example of such a tool would be an object designed to move a wood block while avoiding obstacles; another example is a tool constructed to remove a block with a hook on it from a jar. The defining properties of the tools are at the level of relationships such as the length, inclination, or curvature of different constituent parts. These parts are no longer defined in isolation by means of specific properties, but, rather, they are defined by their mutual relationships. Such a conception of the tool can be described as morphological, formal, or abstract and, therefore, corresponds to the formal or abstract capacities for analysing and segmenting words. The second level is characteristic 7- and 8-year-old children.

Segmentation and composition are possible at both levels, where they are completely different in nature. It is as if, for 4- and 5-year-old children, the tool is gradually defined by juxtaposition of segments or pieces, each one having a defined property or a direct relationship to the child's different actions (semantic aspect). This is reminiscent of the figural collections defined by Inhelder and Piaget (1964) in the realm of classifications (synthesis by semantic analysis strategy).

In contrast, at the second level for 7- and 8-year-olds, the tool is defined by a global transformation relative to certain constraints and conditions inherent in the situations. The tool is defined as a whole composed of parts (which only have meanings with respect to the whole) for which only the structural relationships between parts give it its function (morphological analysis by synthesis strategy).

The features of the tool, of the situation, and of the actions taken into consideration by 4- and 5-year-olds or 7- and 8-year-olds do not have the same status, despite their appearance or, especially, despite our adult observer's point of view. Both cases might deal with 'length', for example, but what the 4- and 5-year-old calls long or short will not have the same meanings as that for the 7- and 8-year-old. In the first case, with 4- and 5-year-olds, we would be in the presence of what Piaget called pre-concepts, where the object and what it signifies are not clearly dissociated. For these children, objects or instruments are characterized by isolated properties or components which may be juxtaposed to make up what we might call 'amalgams' (Wermus 1977). Object properties are directly dependent on the meaning of actions performed on them or for which they are substituted. Objects represent or stand for actions. They are a kind of transposition of actions, an analogue translation, a 'substitute'. Their definition will depend on the presence or absence of this or that segment to which a particular meaning is attached and where the whole is not taken into account.

With 7- and 8-year-old children, the instruments become the 'support' for meanings attributed to the whole, which are no longer relative to such and such particular actions but to one or several transformations of the whole. The instruments are no longer defined by the presence or absence of this or that isolated characteristic but uniquely by the relationships between their different parts.

The age of 6 years constitutes the transition between these two levels of organization. It is at around 6 years that the integration of previously isolated and juxtaposed elements with defined properties take place, which eventually give rise to wholistic meanings enabling transformations to be considered. I noticed that when the children succeeded in defining an instrument by means of a wholistic property, they were momentarily unable to construct or modify an instrument. They were only satisfied by the discovery of an instrument which had the whole set of anticipated characteristics.

Before 6 years it would be possible to say that objects do not exist 'conceptually' for the subject as wholes. Their sole conceptual existence would be linked to the current or previous actions associated with them and for which they act as a kind of extension or substitute. The objects would only have partial, local, and momentary 'conceptual' identity.

From (about) the age of 6, objects become identifiable in a stable and global way, and they have acquired a global identity without the relationships between parts of the object or between different objects having been mastered yet. Their identity no longer depends upon current contingencies of the action but is still limited by the degree of organization of the relationships the child is capable of mastering, both between the constituent parts of the object and between different objects.

It is noteworthy that Vinter and myself have found the two major steps of the general process in our research on the development of the self-image in the child from 3 to 11 years of age (Mounoud and Vinter 1985). This research studied the precision and stability of the child's image of his own face using a distorting mirror. In particular, we were studying the way in which children are affected by their initial confrontation with distortions of their face. Our findings were that, at age 6, children had a precise and faithful representation of themselves.

Similarly, in our research on the planning and control of movements, in the study of visuo–manual tracking of periodic signals in 3- to 9-year-old children (Mounoud 1982; Mounoud *et al.* 1985), we have described the passage from 'local control' to 'global control' of movement, which we interpret as the child's capacity for anticipating the 'to-and-fro' movements of the target and their arm movements as a totality, rather than locally, step-by-step, in a way which then permits the resolution of the problem of coincidence between target movements and their own movements.

Conclusion

In this presentation, I have tried to describe a general process which is not domain-specific in order to explain the successive emergence of different types of thought (semantic versus morphological) at each developmental stage. This process cannot be correctly understood without a definition of the initial stage. Given the recursive nature of this general process, any final state thus generated can itself become an initial state for the following one. Nevertheless, as far as ontogenesis is concerned, it is important to define the initial stage of the new-born (which can be considered as the final state of embryogenesis). I have described the initial state of the new-born in terms of intersensori–motor co-ordinations determined by what has been called preformed global representations (Mounoud and Vinter 1981).

During a first phase of thematizing, new *elementary representations* (analogic) based on meaningful components are constructed by means of a new encoding system (semantic segmentation or analysis). These elementary representations are either isolated or composed into particular unbounded configurations described as 'juxtaposed' or 'reduplicated'. These compositions or configurations can be called 'amalgams' (Wermus), 'appositions' (Bogen 1969), or 'figural collections' (Piaget).

Then the elementary representations are integrated or co-ordinated in *total representations* (symbolic), or bounded initially non-decomposable wholes resulting from 'perceptual grouping' or 'cognitive chunking' of semantic units. During a second phase, these total representations are progressively analysed from a morphological point of view into abstract units defined by the segmentation of their dimensions and their interrelationships (morphological segmentation or analysis).

Afterthoughts

After this presentation, we discovered an exciting paper by MacNeilage (1986), who with his colleagues has recently formulated an interesting hypothesis on the relationship between the beginnings of speech and bimanual co-ordination from an evolutionary perspective (MacNeilage *et al.* 1984). They suggest that left-hemisphere manual specialization may have evolved primarily for bimanual co-ordination rather than simply for manual functions in general. They also consider that the primary specialization of the left hemisphere is for a 'frame and content mode of organization' which is probably used both for bimanual co-ordination as well as for the phonological and syntactic level of speech production. Finally, they hypothesize that the frame and content mode of bimanual co-ordination and its associated hemispheric specialization is probably not specific to hominids but may also be present in Old World monkeys and perhaps also in great apes.

The hypothesis of the frame/content mode of organization at the phonological level of speech is based on an observation made by Shattuck-Hufnagel (1979) related to serial ordering errors in speech production. In particular, in order to explain exchange errors, it is necessary for the subject to separate syllabic structure (frame) from segments (content). Therefore, it is suggested that at the phonological level, speech production includes a stage in which phonological content elements—consonants and vowels—are inserted into syllable structure frames.

MacNeilage (1986) notes in Garret's study (1975) similar errors at the morphosyntactic level of speech: exchange position errors (inside a given syntactic context). These errors demonstrate the intervention of the frame/content mode of organization. In sum, for these authors, evolution would consist of the transposition of the frame/content mode of organization from bimanual co-ordinations to the phonological level of speech and then from the phonological to the syntactic level. Concerning the neurophysiological bases of this frame and content mode of organization, MacNeilage (1986) considers that the supplementary motor area (SMA) located in the superior frontal gyrus of the medial surface of the cerebral hemispheres, as well as other functionally related subcortical areas in the basal ganglia, ventral thalamus, and in the subthalamic nucleus, play a predominant role. These different cortical and subcortical areas show bilateral activities during unimanual tasks (continuous voluntary motor tasks involving actions more complex than single repeated gestures) as well as during speech production. He considers that the importance of the SMA in language has been underestimated.

I consider there to be important convergences between the hypotheses developed by MacNeilage and his colleages and those I have presented here and in previous publications (for example, Mounoud 1986). I have tried to compare the development of reaching to the first phases of speech production in order to characterize structural similarities between these two developmental sequences. More precisely, I have tried to demonstrate the appearance of a new type of segmentation of totalities and of the integration of segments at the beginning of the second year of life (morphological segmentation of totalities in abstract units and integration of elements in bounded totalities which are more than the sum of their parts). With MacNeilage, I am in favour of considering one-handed movements as a special subclass of bimanual control. I have also tried to emphasize the analogy between this new organization and the one that appears at around age six related to word segmentation when learning to read in the alphabetic system, in addition to its similarity to the organization at the morphosyntaxic level of speech (Mounoud 1986).

With regard to reading development, I was very impressed by Gladstone and Best's (1985, p. 98) hypothesis related to interhemispheric collaboration and what they call the time-integrated notion of callosal function, 'when callosal function is considered across diachronic [developmental] time'. As a

brief reminder, the role of the callosum is both *facilitory* and *inhibitory*, regulating the flow of information *into* and *between* the cerebral hemispheres. The corpus callosum also forms an integral part of the system that regulates attentional capacities and attention balance. Finally, the anterior region of the callosum is involved in the co-ordination of bimanual motor skills. Gladstone and Best refer to the model of developmental change in hemispheric involvement in complex tasks (proposed by Goldberg and Costa 1981) based on differences in the cortical representation of novel versus acquired information. The right hemisphere would serve to code novel information, while the left hemisphere would be best suited for reporting *already acquired, compactly coded information*, the sequence of knowledge acquisition following a shift from right to left hemispheres. I suggest that the two-phase model I presented might be based on such a shift from right to left hemispheres or at least on a major change in interhemispheric collaboration. With regard to my model, this change in hemispheric involvement would be repeated several times in the course of development, mainly at around nine months and six years.

Acknowledgements

I would like to thank Stephanie Shine for translating the text, Françoise Schmitt for her valuable secretarial assistance, and A. Caramazza, C. A. Hauert, A. de Ribaupierre, D. Stern, A. Vinter, and G. Zanone for their very helpful comments.

References

Alegria, J. and Morais, J. (1979). Le développement de l'habileté d'analyse phonétique consciente de la parole et l'apprentissage de la lecture. *Archives de Psychologie*, **47**, 251–70.

Bever, T. G. (1982). Regression in the service of development. In *Regressions in mental development: basic phenomena and theories*, (ed. T. G. Bever), pp. 153–88. Lawrence Erlbaum Associates, Hillsdale, NJ.

Bisiach, E. (1988). Language without thought In *Thought without language*, (ed. L. Weiskrantz), pp. 464–84. Oxford University Press.

Bogen, J. E. (1969). The other side of the brain III: an appositional mind. *Bulletin of the Los Angeles Neurological Society*, **34**, 135–62.

Bower, T. G. R., Broughton, J. M., and Moore, M. K. (1970*a*). The coordination of visual and tactual input in infants. *Perception and Psychophysics*, **8**, 51–3.

——, Broughton, J. M., and Moore, M. K. (1970*b*). Demonstration of intention in the reaching behavior of neonate human. *Nature*, **228**, 679–81.

Braine, M. D. (1963). The ontogenesis of English phrase structure: the first phraze. *Language*, **39**, 1–14.

Bushnell, E. W. (1982). Visual-tactual knowledge in 8, 9½, and 11 month-old infants. *Infant Behaviour and Development*, **5**, 63–75.

Crystal, D. (1979). Prosodic development. In *Language acquisition: studies in first language development*, (ed. P. Fletcher and G. Garman). Cambridge University Press.

de Bellefroid, B. and Ferreiro, E. (1979). La segmentation du mot chez l'enfant. *Archives de Psychologie*, **47**, 1–35.

Dromi, E. (1986). The one-word period. In *Stage and structure*, (ed. I. Levin), pp. 220–45. Ablex, Norwood, NJ.

Edwards, M. L. (1974). Perception and production in child phonology: the testing of four hypothesis. *Journal of Child Language*, **1**, 205–19.

Ferguson, C. A. (1986). Discovering sound units and constructing sound systems: it's child play. In *Invariance and variability of speech processes*, (ed. J. S. Perkell and D. H. Klatt), pp. 36–57. Lawrence Erlbaum Associates, Hillsdale, NJ.

Fodor, J. A., Bever, T. G., and Garrett, M. (1974). *Psychology of language*. McGraw-Hill, New York.

Garnica, O. (1973). The development of phonemic speech perception. In *Cognitive development and the acquisition of language*, (ed. T. E. Moore), pp. 215–22. Academic Press, New York.

Garrett, M. (1975). The analysis of sentence production. In *The psychology of learning and motivation*, vol. 9, (ed. G. Bower), pp. 133–77. Academic Press, New York.

Gladstone, M. and Best C. T. (1985). Developmental dyslexia: the potential role of interhemispheric collaboration in reading acquisition. In *Hemispheric function and collaboration in the child*, (ed. C. T. Best), pp. 87–118. Academic Press, New York.

Goldberg, E. and Costa, L. (1981). Hemispheric differences in the acquisition and use of descriptive systems. *Brain and Language*, **14**, 144–73.

Gregoire, A. (1937). L'apprentissage du langage: les deux premières années. Bibliothèque de la Faculté de Philosophie et Lettres, Liège.

Halverson, H. M. (1931). An experimental study of prehension in infants by means of systematic cinema records. *Genetic Psychology Monographs*, **12**, 107–285.

Harnad, S. (1982). Metaphor and mental duality. In *Language, mind, and brain*, (ed. T. W. Simon and R. J. Scholes), pp. 189–211. Lawrence Erlbaum Associates, Hillsdale, NJ.

Inhelder, B. and Piaget, J. (1955). *De la logique de l'enfant à la logique de l'adolescent*. Presses Universitaires de France, Paris.

—— and —— (1964). *The early growth of logic in the child*. Norton, New York.

Jusczyk, P. W. (1985). On characterizing the development of speech perception. In *Neonate cognition: beyond the blooming buzzing confusion*, (ed. J. Mehler and R. Fox), pp. 199–229. Lawrence Erlbaum Asociates, Hillsdale, NJ.

Kugler, P. N., Kelso, J. A. S., and Turvey, M. T. (1982). On the control and coordination of naturally developing systems. In *The development of movement control and coordination*, (ed. J. A. S. Kelso and J. E. Clarke), pp. 5–78. John Wiley, Chichester, Sussex.

Liberman, I. Y., Shankweiler, D., Fischer, F. W., and Carter, B. (1974). Reading and the awareness of linguistic segments. *Journal of Experimental Child Psychology*, **18**, 201–12.

——, ——, Liberman, A. M., Fowler, C., and Fischer, F. W. (1977). Phonetic segmentation and reading in the beginning reader. In *Toward a psychology of*

reading, (ed. A. S. Reber and D. L. Scarborough), pp. 000. John Wiley, New York.

Lockman, J. J. and Ashmead, D. H. (1983). Asynchronies in the development of manual behavior. In *Advances in infancy research*, vol. 2, (ed. L. P. Lipsitt and C. K. Rovee-Collier), pp. 113–36. Ablex, Norwood, NJ.

MacKain, K. S. (1987). Filling the gap between speech and language. In *The emergent lexicon: the child's acquisition of a linguistic vocabulary*, (ed. M. D. Smith and J. L. Locke). Academic Press, New York.

MacNeilage, P. F. (1986). Bimanual coordination and the beginning of speech. In *Precursors of early speech*, (ed. B. Lindblom and R. Zetterström), pp. 189–201. Stockton Press, Oslo.

——, Studdert-Kennedy, M., and Lindblom, B. (1984). Functional precursors to language and its lateralization. *American Journal of Physiology*, **246,** (Regulatory Integrative Comp. Physiol. 15), R912–R914.

McNeill, D. (1970). *The acquisition of language: the study of developmental psycholinguistic.* Harper and Row, New York.

McShane, J. (1980). *Learning to talk*. Cambridge University Press.

Mehler, J. (1983). La connaissance avant l'apprentissage. In *Le développement dans la première année* (ed. S. de Schönen), pp. 129–55. Presses Universitaires de France, Paris.

Menyuk, P. and Menn, L. (1979). Early strategies for the perception and production of words and sounds. In *Language acquisition: studies in first language development*, (ed. P. Fletcher and M. Garman), pp. 49–70. Cambridge University Press.

Morais, J., Alegria, J., and Content, A. (1987). The relationships between segmental analysis and alphabetic literacy: an interactive view. *Cahiers de Psychologie Cognitive*, **7,** 415–38.

Mounoud, P. (1970). *Structuration de l'instrument chez l'enfant.* Delachaux and Niestlé, Paris.

—— (1973). Les conservations physiques chez le bébé. *Bulletin de Psychologie*, **312**(13–14), 722–8.

—— (1982). Psychological revolutions during childhood. In *Regressions in mental development: basic phenomena and theories*, (ed. T. G. Bever), pp. 119–31. Lawrence Erlbaum Associates, New York.

—— (1981). Cognitive development: construction of new structures or construction of internal organizations. In *New directions in piagetian theory and practice*, (ed. I. E. Sigel, D. M. Brodzinsky, and R. M. Golinkiff), pp. 99–114. Lawrence Erlbaum Associates, Hillsdale, NJ.

—— (1983). L'évolution des conduites de préhension comme illustration d'un modèle du développement. In *Le développement dans la première année*, (ed. S. de Schönen), pp. 75–106. Presses Universitaires de France, Paris.

—— (1985). Similarities between developmental sequences at different age periods. In *Stage and structure*, (ed. I. Levin), pp. 40–58. Ablex, Norwood.

—— (1986). Action and cognition. Cognitive and motor skills in a developmental perspective. In *Motor development in children*, (ed. M. G. Wade and H. T. A. Whiting), pp. 373–90. Nijhoff, Dordrecht.

—— (1987). L'utilisation du milieu et du corps propre par le bébé. In *Encyclopédie de la Pléiade. La psychologie*, (ed. J. Piaget, P. Mounoud, and J. P. Bronckart), pp. 563–601. Gallimard, Paris.

—— and Bower, T. G. R. (1974). Conservation of weight in infants. *Cognition*, **3**(1), 29–40.

—— and Hauert, C. A. (1982). Development of sensori-motor organization in young children: grasping and lifting objects. In *Action and thought: from sensori-motor schemes to symbolic operations*, (ed. G. Forman), pp. 3–35. Academic Press, New York.

—— and Vinter, A. (1981). Representation and sensori-motor development. In *Infancy and epistemology: an evaluation of Piaget's theory*, (ed. G. Butterworth), pp. 200–35. Harvester Press, Brighton, Sussex.

—— and —— (1985). Development of self-image in 3 to 11 years-old children. In *The future of Piagetian theory: the neo-Piagetians*, (ed. V. Shulman, L. C. R. Restaino, and L. Butler), pp. 37–69. Plenum Press, New York.

——, Viviani, P., Hauert, C.-A., and Guyon, J. (1985). Development of visuo-manual tracking in 5- to 9-year-old-children. *Journal of Experimental Child Psychology*, **40**, 115–32.

Piaget, J. (1952). *The origins of intelligence in children.* International University Press, New York.

—— (1978). *Success and understanding.* Routledge and Kegan Paul, Andover, Hants.

——, and Inhelder, B. (1948). La représentation de l'espace chez l'enfant. Presses Universitaires de France, Paris.

Rozin, P. and Gleitman, L. R. (1977). The structure and acquisition of reading 2: the reading process and the acquisition of the alphabetic principle. In *Toward a psychology of reading*, (ed. A. S. Reber and D. L. Scarborough), pp. 55–142. John Wiley, New York.

Sakamoto, T. and Makita, K. (1973). Japan. In *Comparative reading: cross-national studies of behavior and process in reading and writing*, (ed. J. Downing), Macmillan, New York.

Shankweiler, D. and Liberman, I. Y. (1976). *Exploring the relations between reading and speech.* Haskins Laboratories Status Report on Speech Research, SR-45/46, 1–16.

Shattuck-Hufnagel, S. (1979). Speech errors as evidence for a serial ordering mechanism in sentence production. In *Sentence processing: psycholinguistic studies presented to Merril Garrett*, (ed. W. E. Cooper and E. C. T, Walker), pp. 91–127. Lawrence Erlbaum Associates, Hillsdale, NJ.

Shvachkin, N. K. (1973). The development of phonemic speech in early childhood. In *Studies of child language development*, (ed. C. A. Ferguson and D. I. Slobin), pp. Holt, Rinehart and Winston, New York.

Stark, R. E. (1979). Prespeech segmental feature development. In *Language acquisition: studies in first language development*, (ed. P. Fletcher and M. Garman), pp. 15–32. Cambridge University Press.

Studdert-Kennedy, M. (1986). Sources of variability in early speech development. In *Invariance and variability of speech processes*, (ed. J. S. Perkell and D. H. Klatt), pp. 77–84. Lawrence Erlbaum Associates, Hillsdale, NJ.

Trevarthen, C. (1979). Communication and cooperation in early infancy: a description of primary intersubjectivity. In *Before speech: the beginning of interpersonal communication*, (ed. M. Bullowa), pp. 321–47. Cambridge University Press.

—— Hubley, P., and Sheerman, L. (1975). Les activités innées du nourrisson. *La Recherche*, **56**, 447–58.

Vinter, A. (1985). *L'imitation chez le nouveau-né*. Dalachaux et Niestlé, Paris.

—— (1986). The role of movement in eliciting early imitations. *Child Development*, **57,** 66–71.

—— (1987). Les fonctions de représentation et de communication dans les conduites sensori-motrices. In *Encyclopédie de la Pléiade. La psychologie*, (ed. J. Piaget, P. Mounoud, and J. Bronckart), pp. 417–62. Gallimard, Paris.

—— (in press). Sensory and perceptual control of action in early development. In *Perception and action relationships: current approaches*, (ed. W. Prinz and O. Neuman).

Von Hofsten, C. (1982). Eye–hand coordination in the newborn. *Development Psychology*, **18,** 450–61.

—— and Rönnqvist, L. (in press). Preparation for grasping an object: a developmental study. *Journal of Experimental Psychology*.

Vygotsky, L. S. (1962). *Thought and language*. MIT Press, Cambridge, MA.

Werker, J. F. and Tees, R. C. (1983). Developmental changes across childhood in the perception of non-native speech sounds. *Canadian Journal of Psychology*, **37,** 278–86.

Wermus, H. (1977). Essai de développement d'une prélogique à partir des foncteurs partiels. *Archives de Psychologie*, **45,** 85–100.

White, B. L., Castle, P., and Held, R. (1964). Observation on the development of visually directed reaching. *Child Development*, **35,** 349–64.

Zlatin, M. (1975). Explorative mapping of the vocal trad and primitive syllabification in infancy: the first six months. Paper presented at the American Speech and Hearing Association Convention, Washington DC, pp. 18, 20–1, 26.