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From meta-processes to conscious access: Evidence from children's metalinguistic and repair data*

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...young children know something about language that the spider does not know about web-weaving (Gleitman, Gleitman & Shipley, 1972, p. 160)

Abstract

This paper explores possible relations obtaining between unconscious meta-processes and those available to conscious access and verbal statement. It is argued that the issue of conscious access must be conceptualized within a developmental perspective, in order to understand its function in human cognition. A theoretical framework is specified, in the form of a recurrent 3-phase model (differentiated from stage models), which stresses the distinction between implicitly defined representations and progressive representational explicitation at several levels of processing, culminating in the possibility of conscious access. The role of conscious access, as well as that of negative and positive feedback, are discussed in the light of a distinction drawn between models of developmental sequence and models of information processing flow in real time. Prominence is given to a success-based model of representational change as opposed to a failure-based model of behavioural change. The data consist

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of a detailed comparison of children's metalinguistic responses and spontaneous repairs. It is argued that metalinguistic awareness has little or no role to play in language *acquisition* macrodevelopmentally, *a minor role to play in linguistic processing in* real time, *but that verbally encoded representations have an essential role to play in* overall *macrodevelopment. The implications of the model are briefly examined with respect to the representational status of the fluent language of some children with low IQ and that of fluent adult speakers of a non-native language. Consideration is given to the fact that some aspects of language, but not others, are available to conscious access. This leads to speculations with respect to the plausibility of considering modularity as a* product *of some aspects of development, rather than restricting modularity solely to innate givens.*

1. Introduction

Metacognition has been a topic of increasing concern to developmentalists over recent years. Research has been carried out on the metacognitive aspects of problem solving, strategy selection, strategy modification, memory devices, language, etc. (e.g. Borkowski, Levers, & Gruenenfelder, 1976; Brown, 1978, 1980; Cazden, 1976; Downing & Oliver, 1973; Flavell, 1976; Flavell & Wellman, 1977; Gleitman, Gleitman, & Shipley, 1972; Hakes, 1980; Herriman, 1984; Hirsh-Pasek, Gleitman, & Gleitman, 1978; van Kleeck, 1982; Lopez Ornat, 1982; Lunzer, 1979; Markman, 1977; Papandropoulou & Sinclair, 1974; Piaget, 1978; Rey-Debove, 1978; Wellman, 1985, and the bulk of work reviewed in Levelt, Sinclair, & Jarvella, 1978). However, in almost every case, evidence for "meta" processes is adduced from data in the form of *consciously accessible, verbally statable* explanations on the part of the child. In this paper I will not restrict my use of the notion of meta-processes in this way; I will take evidence not only from metalinguistic judgements but also from spontaneous repair data, to explore the relationship between unconscious meta-processes and those which are available to conscious access and verbal statement.

Previous studies of metalinguistic awareness have in the main aimed at describing a sequence of developmental stages of metalinguistic capacities and their relationship to Piagetian cognitive structures (e.g., Hakes, 1980; Papandropoulou & Sinclair, 1974; van Kleeck, 1982). Attention has rarely been focused on the *function* that metalinguistic awareness might have in ongoing development or on the clues that conscious metalinguistic statements could provide with respect to unconscious processes. As Marshall and Morton (1978) neatly put it, metalinguistic awareness has been studied outside normal

language production and comprehension as a "cognitive optional extra".

There are none the less a few discussions in the developmental literature of the psychological function and process of metalinguistic awareness (Tunmer & Herriman, 1984). It has been argued that awareness of spoken language has a (necessary) facilitative role for the development of skills in writing/reading (e.g., Böhme, 1983; Brown, 1980; Donaldson, 1978; Lundberg, 1978; Savin, 1972; Tunmer & Bowey, 1980). The issue of process has been addressed by Marshall and Morton (1978) in an attempt to incorporate awareness functionally into on-line language production and comprehension processes. The authors argue that "awareness" corresponds to the operation of an error-detecting mechanism which has access to subparts of the primary linguistic comprehension and production systems. The child passes from error detection, to specific error location and then to error repair. Marshall and Morton hypothesize that the comprehension system "teaches" the production system via error description and rule transmission, by calling on an "awareness operator".

The Marshall/Morton model has the advantage, rare in the developmental literature, of being spelled out explicitly. However, if the awareness module ("EMMA")[1] is to be taken as being more deeply conceptualized than a mere monitoring device (which could of course run *without* awareness), then two implications of the model are, in my view, questionable. First, the information-processing flow, as it now stands, implies that the events which correspond to awareness *must* precede overt repair. This could merely be an empirical issue requiring some modification to the model if data were to indicate the contrary. But the formulation also has conceptual implications since much depends on the way in which one stretches the meaning of "awareness". Stretched too far, the notion of awareness could become meaningless. Indeed, as the authors themselves point out, in most cases where awareness has been invoked to explain data, a mere monitoring device would suffice. Further, the awareness operator in the Marshall/Morton model has no developmental component but only an on-line synchronic one. Indeed, their information processing approach to child language is not developmental; it is aimed at providing an account of the role of awareness in on-line information processing flow, as is the case with models of adult consciousness (Carr, 1979; Frith, 1981; Mandler, 1985; Marcel, 1983; Shallice, 1972, 1978). Clearly, this type of information processing approach cannot account for changes across age groups with respect to qualitative differences in degrees

[1]In their chapter, "EMMA" stands for an awareness operator which, compared to other aspects of language acquisition, the authors call an "Even More Mysterious Apparatus" or, (and I just cannot resist!), perhaps they meant an "Eloquent Marshall Morton Aberration"!

of awareness (Tunmer & Herriman, 1984) which have been documented in the developmental literature (Clark, 1978). From a developmental perspective, a conceptualization is still required of changes in the child's internal representational system, so as to link some form of "awareness operator" at the lower levels of processing, to "awareness" in its consciously accessible, verbally statable form.

A second implication of the Marshall/Morton model stems from the fact that it is failure driven. If one were to extend this information processing approach to an account of macrodevelopment, it would imply that if any part of the linguistic system were to be acquired successfully, without happening to come up against failure, then no awareness could occur with respect to that part of the system. This is because the model stipulates that the awareness operator is only called in the case of error detection. The authors do not address the distinction between development and on-line processing and, although it appeared in an edited volume almost entirely devoted to macrodevelopment, the Marshall/Morton model seems to be aimed only at accounting for on-line processing; the role attributed to awareness and failure appears to be equally applicable to adult or child output. In the main the literature which has focused on macrodevelopmental sequence also considers linguistic awareness to be rooted in failure detection and repair, e.g. detection of mismatch between linguistic form and semantic representation, between communicative intent and outcome, etc. (see review in Levelt et al., 1978).

Although failure certainly does play a role in provoking behavioural change and adjunctions to representations, particularly in on-line processing, I have consistently challenged the generality of the notion of solely failure-dependent progress with respect to representational change in macrodevelopment (Karmiloff-Smith, 1979a, 1979b, 1984). I will address this issue in detail in the present paper because of its particular relevance to the changing nature of children's internal representations and the observer's clues thereto via metalinguistic and repair data. I will argue against certain implications of the Marshall/Morton model and attempt to demonstrate: (i) both empirically and theoretically, that repair precedes awareness macrodevelopmentally; (ii) that awareness must be conceptualized within a macrodevelopmental framework to understand its function and its relationship to other unconscious meta-processes; and, (iii) that meta-processes can and do occur without failure. I shall thus give prominence to a success-based representational model of development, rather than to a failure-based behavioural model of development.

As pointed out above, outside the rare theoretical discussions of metalinguistic awareness, most empirical studies have concentrated on metalinguistic capacities in their own right (e.g., van Kleeck, 1982; Papandropoulou & Sinclair, 1974), rather than on issues of the function that metalinguistic aware-

ness might have in language acquisition. One of the exceptions to this is a fullscale experimental study analysing the possible correlation between children's linguistic awareness and their actual performance (Böhme, 1983; Böhme & Levelt, 1979). The study involved the German possessive and gender-marking systems and used elicitation procedures with children to obtain different levels of awareness via error detection, correction and explanation. The longitudinal, correlational measures showed that a high level of awareness at test 1 was predictive of high level of performance at test 2 five months later. By contrast, high level of performance at test 1 was not predictive of high level of either performance or awareness at test 2. Böhme's findings suggest that provoking explicit awareness via error detection, correction and explanation can in some cases have an influence on subsequent performance. But this begs the question of whether explicit awareness *necessarily* affects spontaneous acquisition processes involved in representational change. Thus, empirical research on children's metalinguistic awareness has been carried out either as an end in itself or to measure effects on performance. Even in the latter cases, focus has not been on the underlying process of representational change. By contrast, repair data have been used in an attempt to account for more general aspects of the process of children's language acquisition (e.g. Bowerman, 1982a, 1982b; Clark, 1978; Clark & Andersen, 1979; Karmiloff-Smith, 1979a, 1979b, 1984, 1985; Käserman, 1979) and for a deeper understanding of adult language (e.g., Cutler, 1982; Levelt, 1983).

Clark (1978) is one of the rare developmentalists to have sought to establish a macrodevelopmental link between the phenomenon of spontaneous repairs and that of overt, verbalized metalinguistic judgements. Clark argues that they form part of the same developmental continuum, with children's understanding of puns and riddles falling between the two. Such a continuum suggests interesting patterns with respect to an evolving behavioural sequence, but it is unspecified as to process, i.e., how transition takes place from one level to another. The Marshall/Morton model discussed above does address the process issue, i.e., a possible on-line link between repairs and awareness, but from a non-developmental (non-evolving) perspective. The theoretical framework in which to situate macrodevelopmental representational relations between the processes underlying both repairs and metalinguistic awareness remains to be worked out.

This paper is an attempt to provide such a theoretical framework, which is outlined in Section 2.' Section 3 touches briefly on some general methodological problems involved in the use of metalinguistic tasks and repair data, as well as on the validity of making use of elicited metalinguistic judgements within what is intended to be a process-oriented approach to

explaining the dynamics of language acquisition. Section 4a provides an analysis of children's metalinguistic data, and 4b of children's repair data, both taken from the same area of language, that of the determiner system. In Section 4c a comparison is made of the developmental patterns from these two data sources. Finally, in the concluding section, the more general implications of the theoretical framework are explored.

Although I have been developing this framework with respect also to non-linguistic aspects of cognitive change (Karmiloff-Smith, 1979b, 1984, and earlier references therein), this paper will focus specifically on language. In the conclusions I will touch on the possible implications of the theoretical framework for the analysis of certain types of mental subnormality, as well as for gauging the representational nature of fluent second-language output in adults. However, the main part of the paper will address first-language acquisition in normal children. Throughout, the major focus will be on the *recurrent* passage from implicit linguistic representations to progressive representational explicitation at several levels of processing.

2. Theoretical framework

In this section, I will outline the theoretical framework within which I relate metalinguistic and repair data and how I interpret them within a general process-oriented model of the changing nature of children's internal representations. Although I have placed stress on language-specific constraints in the process of language acquisition and have argued that language is a problem space per se for children, I have none the less always considered language acquisition within the broader framework of human problem solving. I consider language acquisition to be in part determined by innately given linguistic constraints and subsequently in part by general processes of representational explicitation, particularly with respect to lexico-morphology. The model to be outlined below is to some extent applicable to general cognitive development, but here those aspects which are most directly relevant to language will be focused upon.

Two general notions are basic to the model and differ substantially from the work reviewed in the introductory section. First, I do not restrict the notion of "meta" to conscious accessibility. Second, I contend that the prerequisite of fundamental macrodevelopmental change, in the form of progressive explicitation and restructuring of representational relationships, is "success" (i.e., positive feedback mechanisms) rather than failure (i.e., negative feedback mechanisms). By contrast, behavioural change is based on both negative and positive feedback.

The argument to be developed in this paper is that, between the acquisition processes (that all normal children develop to produce and comprehend utterances) and conscious, statable awareness (that normal children attain with respect to some, but not all, aspects of the linguistic system), lie meta-processes—that I have termed "metaprocedural"—which are an unconscious, fundamental aspect of the way in which developing children spontaneously "work" on their linguistic representations outside normal input/output relations.

Several developmental psychologists have grappled with the issue of unconscious processes, such as the so-called "reorganizational processes" which are inferred from modifications and/or errors in children's behaviour that occur after a long period of consistently correct output (Bowerman, 1982a, 1982b; Karmiloff-Smith, 1979a, 1979b; Newport, 1982; Strauss, 1982). The internal processes are unconscious for the child and obviously unobservable to the researcher who can but infer them from the U-shaped behavioural sequence. It is not easy to adequately describe the inferred internal processes at work in the young child. Bowerman has been particularly sensitive to this problem. Her solution has been to formulate statements such as "the child comes to realize the analogy between..." and to add a footnote to the following effect:

> For lack of more precise terms in English I use the words *recognize, realize, become aware,* etc., to refer to the child's passage from ignorance of a regularity in language structure to knowledge of it, as inferred from changes in her speech. However, I do not intend to imply that the child has any *conscious* awareness of these regularities or could in any way talk about or reflect upon them (Bowerman, 1982a, p. 345; see also Bowerman, 1982b, p. 104).

My own solution to this problem was to use the formulation "the child *becomes sensitive to* the analogy between ..." in the hope that this did not imply conscious access.

In my view, the intuitions regarding unconscious, endogenously-provoked processes are on the right track, but clearly the fundamental problem is hardly the lack of existing terminology. Rather, the theoretical conceptualization of such unconscious reorganizational processes and their explicit specification were hitherto lacking. Much the same applies to the term "implicit" which permeates the developmental literature, but is used atheoretically. To state that the child "has" some knowledge "implicitly" is to imply that the particular knowledge is stored somewhere and in some way. But to stop at such a statement is merely to name the problem and to leave totally unspecified how and in what form such knowledge is stored, indexed, accessed,

restructured, etc. Below, I will briefly outline how notions such as "implicit", "explicit" and "conscious" will be used in this paper, in an attempt to overcome the problem of conscious access where it is not implied (as in representational reorganization), and yet to specifically link conscious access, when it does occur, to other meta-processes of an unconscious type. The distinctions I use are partially based on the procedural/declarative distinction used in Artificial Intelligence and on those made by Hofstadter (1979), Pylyshyn (1978), and more recently by Dennett (1983). But the 4-tier notion developed here does not entirely overlap with any of these, partly because of the developmental dimension I wish to capture, but also because of theoretical distinctions introduced here and which are not part of dichotomous models. The additional distinctions are essential to understanding the subtleties of development, and they may also turn out to be of use in understanding the processes underlying new acquisitions in adult cognition. The theoretical distinctions, between implicit representations and different levels of progressive representational explicitation, are spelt out below.

Implicit (I)

Implicit knowledge (I) is not defined representationally, i.e., the fact that different procedures may have common components is not explicitly represented internally. Implicit knowledge is only potentially definable over the totality of procedures in which it co-occurs. A procedure can only be called upon to run in its totality; its components cannot be accessed and operated on separately. To do this, the procedure has to be redescribed internally.

Primary explicitation (E-i)

Implicit knowledge is redescribed in E-i form in the same representational code (kinaesthetic, spatial, temporal, linguistic) in which it existed in I-form. In other words, the procedural representations of the internal state of the organism for any particular output undergo redescription (i.e., an internal copying operation involving a trade-off between information retained and accessibility). The original, implicitly defined procedures are not deleted; they can still be called upon to run. Hence the need for redescription and the developmental time it takes. Representational redescription means that the knowledge components of a procedure can now be operated on internally, i.e., they are accessible to the operation of metaprocedural processes which make possible the explicit defining of relationships across representations within each code. (Such explicit defining within codes is the *result* of a developmental construction. That process should not be equated with the cross-

modality mechanisms which are innately given in the cognitive system and thus of a very different nature.) Whilst E-i representations contain explicitly defined links, they are not directly accessible to consciousness. To achieve this, representational redescription is again necessary.

These two levels of representation (implicit and primary explicitation) will be further specified as they relate to the 3-phase model to be presented shortly. They need to be differentiated from other levels of representational redescription and explicitation, which are spelt out below and will be relevant to the use of metalinguistic data and the comparison with repair data. I am speculating that there are probably two further levels; at the very least my argument is that a dichotomous model (e.g., implicit/explicit; procedural/declarative) does not suffice to account for development in this respect.

Secondary explicitation (E-ii)

E-ii representations result from a second redescription within the same code in which any particular knowledge was encoded at E-i level. They are now available for conscious access, which is not restricted to the linguistic code. It is important to note that there is no direct conscious access to I-representations, but that two levels of redescription and explicitation are required, i.e., it is not the case that a genetically given "consciousness operator" is simply waiting to address internal representations, but rather that gaining conscious access to represented knowledge is a constructive process which takes developmental time.

Tertiary explicitation (E-iii)

The organism makes use of representational redescription to translate E-ii representations from one code into another. Although the different codes are all involved in this translation process, the code which wins out in E-iii redescription is an abstract one (some form of "mentalese") which is not constrained by spatial, temporal and causal constraints inherent in most other representational codes. This abstract code is thus more amenable to linguistic encoding than other codes which explains why ultimately metacognitive knowledge is frequently available in verbally statable form. Thus the verbal encoding of metacognition is not driven by social communication. The latter is a by-product of an endogenous process. Prior to tertiary explicitation, the fact that the same knowledge may exist in different codes is only represented implicitly. It is only at level E-iii that multiple representations of the same knowledge in different codes become explicitly linked via a common code. The linking of multiple representations of equivalent knowledge across differ-

ent codes gives greater flexibility to the human cognitive system.

It is my view that it is theoretically crucial in accounting for developmental change to differentiate between these distinct levels of representational redescription and explicitation. Hitherto, the term "implicit" has been used in the developmental literature to imply some unspecified amalgam of the notions of implicit and primary explicitation specified above. Yet I believe that they are very distinct levels of representation, a distinction essential to understanding development. They are both to be distinguished from accessible, verbally encoded knowledge to which the term "explicit" has been mainly confined in the literature. It is my general argument that two level dichotomies used up to now, such as implicit/explicit, procedural/declarative, first/second order, unconscious/conscious, representational/metarepresentational, etc. are insufficient to capture the complex nature of the processes leading to conscious access.

The different levels of representational redescription and explicitation defined above are relevant to general processes of change. For some time I have been developing a 3-phase model of children's general problem solving in macrodevelopment (Karmiloff-Smith, 1984 and earlier references therein). Furthermore, provided a problem-solving task is well within a subject's cognitive capacity, the 3-phase cycle is sometimes detectable in processes which operate in parallel to on-line computations in microdevelopmental tasks (Karmiloff-Smith, 1979*b*, 1984). In this paper, I will focus only on the macrodevelopmental aspects of language acquisition. I will present the model in somewhat more detail than in other publications, incorporating into it the above distinctions between I- and E-i representational changes. The relevance of E-ii/E-iii redescription and explicitation, which occur only after the completion of each 3-phase cycle, will be taken up in the concluding section of the paper. It is important to stress that the three developmental phases are *not* general cognitive "stages", nor are they domain-specific "levels", i.e., phases are not age-related at all (see Karmiloff-Smith, 1984, for discussion of stage/level/phase). Rather, phases are *recurrent* cycles of processes which take place again and again as the different aspects of the linguistic system develop. After a summary of the 3-phase cycles is presented below, a concrete example will be given as an illustration.

Whilst all three phases will be outlined, note that it is the endogenous processes operative at phase 2, and far less the influence of exogenous factors in phases 1 and 3, that are the most relevant to representational change. My work has in fact concentrated on determining phase-2 processes, i.e., development beyond successful output. This contrasts with traditional developmental psycholinguistic accounts which frequently stop at successful output, i.e., they describe the states of initial failure, followed by partial but fragile

success, and finally by robust success. Such accounts would, in the present model, fall only under phase 1. Indeed, many traditional developmental accounts stress behavioural change, and do not address the issue of *representational* change which I consider to be crucial to an understanding of language acquisition and of cognitive development in general.

When considering the three phases, it must be recalled that this is a phase model and not a stage model. Thus, the 3-phase cycle, as well as any particular phase within it, concerns a particular linguistic form (phonological, morphological, lexical, etc.) and not simultaneously the totality of the linguistic system that the child possesses at that time. The child can thus be simultaneously at phase 1 for one form, phase 2 for another, have completed the cycle for one form and not for another.

Phase 1

The first phase has two basic characteristics. First, surface output for a particular linguistic form is predominantly (although of course not exclusively) driven by external stimuli. Second, representations of that form are stored independently of others. The child's goal is to attain one-to-one mapping between the specific linguistic form and the particular extralinguistic/pragmatic context for which it is used in the output of the adult model. The process used is a simple evaluation of match/mismatch between the present state (the child's output in a given context) and the goal state (the child's evolving representation of the adult output and of the context in which it is emitted). If there is a mismatch, the child receives negative feedback (via the internal matching process and also, at times, via social interaction, although correction from adults is not essential within this model). If there is a match between present state and goal state, then a new representation of the phonological form and its contextual use is entered into memory and compiled. At phase 1, such representational adjunctions are not evaluated with respect to the content of other entries. They are merely added to the plethora of existing entries, and there will thus exist multiple identical and/or slightly differing entries.

In my view, the developing child's linguistic (and general cognitive) system is not driven merely by economy. During phase 1 it is driven by the goal of behavioural success and, subsequently during phase 2, it is driven by the goal of control over the organization of internal representations (Karmiloff-Smith, 1979a).

During phase 1 the child continues to receive both positive and negative feedback until she has reached procedural success, i.e. when there is a match between the child's output and adult output and the child's output receives only positive feedback. But any potential relationships between the proce-

dures which generate a correct output are merely represented implicitly. For the child, no representational links have as yet been defined either across procedures which cover different functions but which output the same phonological form, or across those covering identical linguistic functions but outputting different phonological forms. Each form/function pair is represented independently, e.g., in the case of an identical phonological form having different functions, the representations are organized as a series of disconnected form/function pairs containing the equivalent of unifunctional homonyms. Any form/function relationships obvious to the observer are not accessible to the child, given that they are not yet represented in E-i form. This type of account affords an explanation of why children often fail to generalize immediately, because generalization across tasks or problems requires operating on E-i representations, and not solely on compiled I-representations despite the efficacy of the procedures that they generate. Moreover, what can appear to be generalization at the behavioural level may stem from a plethora of identical, multiply-represented procedures. Hence the importance of representational redescription and explicitation if generalization is to take place at the representational level for the child, and not be merely inferred at the behavioural level by the observer.

Despite the limitations of the implicit representations symptomatic of phase 1, it is essential to recall that by the end of the first phase for a particular linguistic form, children have achieved a correct mapping between their output and the adult output (of course, under the hypotheses developed here, the identical output stems from *different* representations between the child and the adult), i.e., children have achieved communicative adequacy in their use of the particular linguistic form. Now, if children were merely driven by the goal of successful mapping between their output and the output of the adult model and/or successful communicative outcome, or if change were solely dependent on failure or conflict, no further development should occur for that form after phase-1 success.

However, later developments provide striking evidence that children go beyond procedural success, i.e. beyond successful mapping operations between their output and the input model and beyond successful communication with addressees (Karmiloff-Smith, 1979b). This human tendency to go beyond success (in both language and non-linguistic areas of cognition) demonstrates, as I have repeatedly argued, that failure (in the form of conflict, negative feedback, etc.) cannot alone explain representational change. Failure does have a role to play in creating procedures in the first place and in generating representational adjunctions and behavioural change, since phase 1 procedures are built from both negative and positive feedback. However, the final stability of phase 1, which cues the passage beyond success to phase

2 and its representational change, is based on repeated *positive* feedback, i.e., it is internal stability, rather than conflict/desequilibrium, which functions as a cue for the onset of representational change. And it is internal stability that enables the child to become sensitive at phase 2 to conflict between potentially competing/inconsistent representations, a conflict ignored for some time developmentally during phase 1. Indeed, the isolated nature of phase 1 representations allows different, potentially conflicting entries to live in "peaceful coexistence". Thus, the stability and "success" of independently stored representations is a prerequisite for real representational change, not in the form of mere adjunctions to memory, but in the explicit defining of relationships across redescribed existing representations.

Phase 2

At the end of phase 1 when procedural success has been attained, a metaprocess is called into play, which has the function of evaluating the internal state of any part of the organism. Phase 2 is characterized by the fact that the child now ignores to a great extent the external stimulus and concentrates on gaining control over the organization of those internal representations which had hitherto been stored independently. After procedural success at the end of phase 1 for a particular linguistic form, a number of metaprocedural operators are set in motion during phase 2 which will enable the implicitly encoded representations to become explicitly related. It was argued above that phase 1 representations are in the form of compiled procedures whose contents cannot be addressed. Thus the initial operation of phase 2 is to redescribe the phase 1 representations in a form which allows for (albeit totally unconscious) access. The information contained in the earlier compiled procedures can now be addressed by the metaprocedural operators. Constraints on the form of redescription involve a certain amount of loss of procedural information still retained in I-representations (e.g., information about the particular phonetic constraints on a particular form) but simultaneously a gain in accessibility of semantic/functional information.[2] Once redescription has taken place in E-i form, those representations can then be scanned, and any form/function analogies and differences can be explicitly defined. The scanning operation will thus be sensitive to identical forms paired

[2]This trade-off between information content and accessibility is a typical feature of certain Artificial Intelligence simulations. An example is Evans' analogy program in which each new level of symbolic description (more appropriate to a particular goal in picture recognition) lacks some information with respect to that contained in other descriptions, e.g., a low level description of points is differentiated from higher level description of lines, and from the highest level description of shapes which does not contain information about points and lines (Evans, 1969).

with different functions and to identical functions paired with different forms. A process is then initiated such that E-i representational links are established and defined explicitly. Ultimately, therefore, one form can have plurifunctional status, as opposed to the plethora of unifunctional form–function pairs symptomatic of phase-1 independently stored representations.

During the metaprocedural operations, the load on the child's internal processing may be too great, causing the occurrence of new errors and/or repairs as compared to the earlier phase-1 successful output. The phenomenon of error after success has been discussed by many developmentalists in terms of U-shaped curves (see, for example, the chapters in Strauss, 1982). However, it is essential to stress, in line with the present model, that the U-shape notion is a description of *behavioural* change and not an account of representational change for which I am proposing a theoretical framework here. In the present model, the U-shape developmental sequence is just one amongst other behavioural indices of representational change. The computational load caused by metaprocedural operations often makes it necessary for the child to mark externally, i.e., behaviourally, the new links which have become defined internally. This behavioural marking acts, in my view, as a form of "cognitive processing prop", rather like the role of linguistic scaffolding in social interaction, of overt rehearsal in memory, of finger counting, and so forth. Within the language data, examples of "cognitive processing props" are evident when the child spells out in unifunctional lexemes what was implicit earlier in a multiply-represented single form, or the child adds special surface marking to one of two identical forms so as to clearly differentiate their pairing with different functions (see examples later).

During phase 2, then, it is no longer the external stimulus (the adult output) that dominates the processes giving rise to behaviour. Rather, children's own internal representations become the predominant focus of their unconscious attention. Whereas during phase 1 children's linguistic outputs functioned as "cognitive tools" for efficient communication, at phase 2 children treat the tools as "cognitive units of attention" per se outside normal input/output relations. Linguistic representations thus become a problem space per se for children. Hence the importance of rewriting I-representations into E-i form, since the component parts of information implicitly represented cannot be accessed and operated upon metaprocedurally.

It is essential to reiterate that phase-2 metaprocedural operations neither require nor involve consciousness. Thus these meta-processes cannot be tapped via tasks involving metalinguistic judgements.[3] They can, however, be

[3]This of course does not imply that children can furnish no metalinguistic responses at the time when they are working unconsciously on their internal representations at phase 2 for a given form or function. They may →

inferred from a specific type of self repair which involves repairs to output that is already syntactically and communicatively adequate. In other words, the repairs are *not* generated by potential ambiguity involving communicative failure; they concern outputs which could have remained unrepaired. It is such "optional" repairs, together with children's tendency to add distinctive markers to distinguish between identical forms having different functions (see examples later), which I will use in this paper as empirical support for the theoretical framework presented.

Note that whilst both positive and negative feedback are used *within phases*, the evaluator which operates *between* phases is cued by positive feedback mechanisms, i.e., it is *not* set into operation by failure of the system. Representational changes do not occur because the system detects an error, or is in a conflictual, disequilibrated state–a precondition frequently invoked by stage theories. Rather, in this process-oriented account of reiterated 3-phase cycles, change across development occurs because the organism has recognized a stability criterion, which cues that it is in control and ready to pass into a new phase in which explicitly defined links are established across previously independently represented entries.

In some cases the explicit link between representations is sufficient to mark analogies of, say, semantic features. In other cases, however, the representations are not only explicitly linked but are actually restructured to form a sub-system per se, such as the determiner system, in which a number of different phonological forms with overlapping discourse functions are grouped together to form a new, systemically organized representation. The operation of defining an explicit representational link, as is general in phase 2, and the further, post phase-3 step of restructuring E-i memory entries into a systemic grouping, both of which have previously been called "reorganization", will be differentiated after the account of phase 3 and, later, via concrete examples.

Phase 3

Just as the prerequisite for the transition from phase 1 to phase 2 is procedural "success", so the passage from phase 2 to phase 3 involves meta-

of course have conscious access at this same time to other, simpler aspects of language (see, for example, Smith & Tager-Flusberg, 1982, for a discussion of preschool metalinguistic knowledge, and Mandler, 1984, for a discussion of conscious recall in the young infant). It should be recalled that (i) this is in part a constructivist model; I am not invoking the simple triggering of a genetically given/maturationally constrained awareness operator, and (ii) this is *not* a stage model, both of which would indeed imply that the capacity for metacognition is set in motion across the board at a certain period of development. By contrast, in a recurrent phase model, the child will be metalinguistically aware of some aspects of language whilst simultaneously having as yet no conscious access to others on which she may, however, already be operating with unconscious meta-processes.

procedural "success", i.e. consolidation and stability with respect to the explicit definition of internal representational links. Phase 3 is characterized by an intricate balance between the reconsideration of external stimuli (the adult model) and the internal representational links established during phase 2. By phase 3, children no longer need the "cognitive processing prop" of externally marked distinctions, and can incorporate into their representations the external stimuli of the input model ignored during phase 2. Thus in phase 3 the additional marking and repairs symptomatic of phase 2 are eliminated. In fact, the child's output at phase 3 is identical to phase-1 output. But this only holds from a behavioural viewpoint. From a representational viewpoint, the phase 3 output is generated from memory entries which are explicitly linked and represented in E-i form. By contrast, the phase-1 output of the same linguistic form stems from direct access to a procedure, i.e., an independently I-represented form/function pair. This indicates how the same output can be generated from very different representations.

Once the 3-phase cycle has been completed for a particular part of the developing linguistic system, a specifically linguistic operation evaluates the phase-3 representations with respect to their appropriateness for systemic restructuring for the needs of on-line discourse computation. Candidates for such restructuring are those markers whose function is not solely governed by sentential or cognitive constraints, but also by their organizational role in extended spans of discourse. I have in mind determiners (articles, pronouns, etc. which organize the structure of the relationship between different protagonists in a span of extended discourse), and aspectual morphology on verbs (durative, punctual, iterative, etc. which mark foregrounding and backgrounding in a span of discourse). In contrast to, say, semantic relations between representations which become explicitly defined, discourse markers are not only explicitly defined but also subsequently restructured to form systemic groupings. The use of a discourse marker is governed by the choice of other *linguistic forms* in prior discourse, forms stored in E-i form in the same sub-system. For a child to have reached a level in narrative production such that there are the beginnings of such discourse organization (see Karmiloff-Smith, 1985, levels 2 and 3 of narrative output), each of the markers used in this way must have already undergone the 3-phase cycle and have been subsequently restructured.

The recurrent passage from I- to E-i representations is, I contend, a *necessary*, unconscious meta-process in normal acquisition. Children pass recurrently through the above three phases for the various parts of the linguistic system that they are in the process of acquiring. It is only once the child has completed the 3-phase cycle that E-i representational links can be rewritten in E-ii/E-iii form and thus be available to conscious access. Within the

framework developed here, it is clearly impossible to pass from I-representations directly to E-ii/E-iii representations, a point of some theoretical importance for pedagogical theory. From the metalinguistic data I will show that explicitly defined relationships and systemic groupings can be ultimately available to conscious access, but that there are also indices of such representational change in self repairs which occur prior to conscious access. Whether, beyond the 3-phase cycles, the passage from E-i to E-ii/E-iii is optional, or is actually also *necessary* for language acquisition, is one of the questions which the data in this paper set out to elucidate, because processes at work in phase 3 continue to operate on E-i representations.

Whilst I hold that functional relationships are of utmost importance in language acquisition, clearly other analogies such as those involving semantics, morphology (e.g., determiners can be pluralized, gender-marked etc.), will also play a role in determining the analogies and differences that the metaprocedural operations explicitly define (Karmiloff-Smith, 1979a). By contrast, it is because there is little if any functional, semantic, phonological or morphological overlap between, say, articles and auxiliary verbs, and because innate syntactic constraints separate them, that one observes no signs of children trying to bring them together into systemic organization. However, *all* representations that pass from I to E-i form may be automatically scanned as part of the metaprocedural operation. The researcher would have no clues to such an unconscious (overly generalized) process since its operation would be curtailed almost immediately in those areas where functional, semantic, phonological, morphological and syntactic overlap is minimal or nonexistent.

A further issue, raised by Bowerman (1982), concerns why one observes clues to reorganizational processes in certain parts of the linguistic system, but not in others potentially open to analogous reorganization on the part of the child. On the basis of the model presented here, I argue that the explicit defining of representational links in other aspects of the language do indeed take place. However, unlike those cases that actually get externalized in the child's behaviour (repairs, errors, differential markings, etc.), many internal processes reveal no observable signs to the investigator at the behavioural level and can only be hypothesized within a specified theoretical framework. Moreover, it could well be that hitherto barely explored clues to representational change may lie in restrictions of use of co-occurring forms to particular genres (Gee & Savasir, 1985), the sudden non-use of a previously consistently used form (Pettito, 1983), modifications to prosodic features, pause patterns etc., beyond the more obvious clues from errors and distinctive surface marking.

Recall that under the previously used global term "reorganization", I have

hypothesized, within the model presented here, two different types of representational change. One involves the actual restructuring of representations into linguistic sub-systems, e.g., the determiner system, thereby setting up new representational entries in memory. By contrast, others, such as the semantic analogies obtaining across, say, two verbs such as "give" and "put" analyzed by Bowerman (1982a, 1982b) would, according to the present model, contain an explicitly defined link in phase 2, but these two verbs would not be candidates for subsequent restructuring systemically, in contrast to the determiner system. The two verbs do have semantic overlap but differ in the animacy/inanimacy of the recipient (viz: I gave the book to the boy/I put the book on the table). However, the contrast between the verbs does not operate as a discourse organizer. When the choice of one of the verbs is made, it is a function of the conceptual level of processing; it is not a function of the level of realization of particular linguistic forms constrained by the previous choice of linguistic forms used in the same span of discourse. Choices involving semantic overlap between such verbs operate conceptually at the sentential level. Choices involving determiners operate also at the discourse level because they are influenced by the prior choice of other determiners.

An explicitly defined link between semantically related verbs would suffice to set up the potential for the occasional, new-occurring errors reported by Bowerman, as well as for adult slips of the tongue. However, it is unnecessary to invoke the restructuring of semantic links into a new representation. It is the constraints of on-line discourse processing that explain why the memory entries for some linguistic terms such as the determiners have to be restructured, whilst for others an explicitly defined link is sufficient. Cases previously all grouped under the unspecified term "reorganization" (Bowerman, 1982a, 1982b; Karmiloff-Smith, 1979a, 1979b) are now differentiated and specified in the present model.

I am not of course suggesting that all linguistic development can be explained by this 3-phase model of representational change which, in general terms, although not in the specifics of detailed processes, can in part be traced to Bloomfieldian distributional analyses (see also Karmiloff-Smith, 1979a; Maratsos & Chalkley, 1980). Clearly, there are innately-given linguistic universals which constrain the child's processing of the input during the initial stages of language acquisition (see Chomsky, 1982, for interesting speculations on initial parameter setting; Gleitman & Wanner, 1984, for suggestions regarding the child's initial parsing of the input, and Slobin, 1985, for a hypothesized set of innately given linguistic operating principles). However, with respect to some of the processes at work in the subsequent representational change regarding the specific relationships to be established in the lexico-morphology of the child's particular mother tongue, I believe that

this 3-phase model of representational change via progressive explicitation and restructuring provides a plausible theoretical framework.

A concrete illustration

Before moving on to the methodological and data sections, I should like to concretize the 3-phase model outlined above by an example. I shall take the case of the child's acquisition of the indefinite article in French (Karmiloff-Smith, 1979*a*). My argument is that during phase 1, children develop one procedure for the non-specific reference function which outputs the phonological form of the indefinite article; another, independently represented procedure for the numeral function which also outputs an indefinite article (French does not differentiate between "a" and "one" in its surface grammar); yet another procedure for the appellative function which again outputs an indefinite article; and so forth for all the functions the indefinite article may have. In other words, at phase 1 the child has stored in memory a plethora of independently represented form-function pairs with respect to the indefinite article and its various functions. Although the procedures all output the same surface form, this fact is not defined explicitly in the child's internal representations. It is only implicit, by dint of the co-occurring form across the plethora of isolated representations. Because of this, there is as yet no way for the child to establish the fact that a common form is paired with different functions across the representations.

Once each separate procedure for outputting the indefinite article has become automatized, compiled, and functions efficiently, i.e., is semantically and communicatively "successful" and receives only positive feedback, this stable internal state is recognized and the rewriting of I-representations into E-i form is set in motion. This is essential because I-representations are compiled and therefore their components cannot be addressed separately. The rewriting into E-i form makes it possible for analogies of phonological form and differences of function across the multiply-stored indefinite articles to be explicitly defined. Then, the plethora of isolated form/function pairs can be linked, after which one form—the indefinite article—has plurifunctional status.

As was shown in the model, phase 2 metaprocedural operations sometimes produce too heavy a processing load and cause children temporarily to create "cognitive processing props", i.e., children add additional markers to some of the form/function pairs to differentiate them from others. For example, children at phase 2 with respect to the indefinite article in French continue to correctly use the indefinite article to imply non-specific reference (e.g., un mouchoir = a handkerchief), but these same children add a partitive when

implying the numeral function of the indefinite article (e.g., un de mouchoir = one handkerchief). I have reported similar processes for a number of other forms such as "même/même de" introducing a surface distinction between identity (same one) and analogy (same kind), both meanings being conveyed by the single form "même" in the adult model (Karmiloff-Smith, 1979a). The externalisation of such surface marking helps the child keep distinct the functional relationships attached to a common phonological form. The child becomes sensitive to such relations via the metaprocedural operation of explicitly defining E-i representational links. The additional marking is dropped at phase 3 when again a single form is used for each of the different functions. The behavioural output at phase 3 is thus identical to that of phase 1 ("un" is used in the two phases to convey both "a" and "one"). However, the identicality does not hold from a representational viewpoint. The very fact that phase-2 differentiated marking occurs *after* the developmentally prior consistently correct output at phase 1 is, I would argue, a clear indication that new internal representational links have become explicitly defined by phase 2. Thus, when phase 3 children *behave* as do phase 1 children, the identical behaviour stems from *qualitatively different representations*.

Much the same would be happening with respect to the acquisition of the different functions of the definite article also, which would pass through the same three phases. But it is also important to stress that the metaprocedural processes will not only be focusing on *form* relationships *within* each article's many functions, but also be picking up potential *functional* relationships *between*, say, the indefinite and definite articles. Just as for each separate article, these relationships first exist implicitly in the independently represented form–function pairs, but later they are redescribed in E-i form. Thus, although the indefinite article may have already been represented in E-i form, and likewise for the definite article, relationships *between* the articles may at that point still exist only implicitly. This stresses a crucial difference between stage theories and the recurrent phase model presented here. It follows that initially the two articles do not form part of a common system, i.e., the "article contrast" does not yet exist for the child even when she is using each article efficiently in different contexts. This does not imply that the two articles are confused by the child at phase 1, but simply that they are independently represented, i.e., their potential links remain implicit. It is only when metaprocedural operations can be initiated on the basis of E-i representations that the progressive formation of the "article contrast" can take place. Once the links between the articles have been explicitly defined, the use of the indefinite article then has as part of its meaning the *non-use* of the definite article in that particular context. The same applies, mutatis mutandis, to the use of the definite article. In phase 1, by contrast, information is only con-

veyed by the *use* of each article and carries no implications about their contrastive meanings. By the time the articles are representationally linked in E-i form to all the nominal determiners, the information carried by the use of any term includes that of the non-use of the other nominal determiners to which it is linked. Whilst the notion regarding contrasts obtaining in lexicomorphology is in line with a long tradition of structural linguistics in the Saussurian vein, the focus in the present account is on the internal processes by which the child progressively comes to change her initial, non-contrastive procedural representations in order to reflect such linguistic contrasts and how this process is part of more general cognitive processing.

It should be reiterated that within this recurrent 3-phase model the child will be simultaneously at phase 1 for one aspect of language, phase 2 for another and phase 3 for yet another. Certain aspects of a particular form may be treated metaprocedurally at the lexemic level (e.g., the introduction of a new, more complex function for a given form, such as the generic function of the definite article) simultaneously with the same form being treated metaprocedurally at the cross-lexemic level (e.g., new analogies being discovered across different forms such as the opposition between unity and plurality expressed for both indefinite and definite articles in singular and plural forms in French).

Because of their functions in on-line discourse computation, the articles are candidates for systemic restructuring at the end of phase 3, and they will thus be progressively stored with other nominal determiners. The choice of a particular nominal determiner in discourse depends crucially on the choice of other nominal determiners used in previous sentences. For instance, although a pronoun gives information about gender and number, the speaker's decision to use (or not to use) a pronoun in on-line discourse is also governed by the fact that the pronoun is stored in the same sub-system as the indefinite and definite articles, proper names, etc., and provides, beyond the semantic features of gender and number, information about the overall referential structure of a flow of discourse in real time. There are for example cases where, at the sentential level, the use of a pronoun would be totally unambiguous; yet a seemingly redundant full NP is preferred by the speaker because of choices of determiners already made in the prior discourse (see Karmiloff-Smith, 1985 and references therein, for discussion of the dynamics of discourse production). The explicitly defined systemic restructuring in memory allows speakers to subtly modulate the choice of referential devices across spans of sentences in ways that isolated representations would preclude.

The model presented in Section 2 has a clear implication, i.e., that the explicit defining of representational links, the metaprocedural scanning for

analogies and differences, the subsequent restructuring processes, can all take place without either failure or awareness. The meta-processes are generated on the basis of success and operate on E-i representations which are not directly available to consciousness. Conscious awareness, by contrast, results from representational redescription from E-i to E-ii/E-iii form. The passage to E-ii/E-iii forms will be discussed in the concluding section. In the section to follow now, a discussion will be made of the relation between methodological problems and the theoretical model. We will then consider the analysis of metalinguistic and repair data which lend support to the model.

3. The relationship between methodological problems and the theoretical model

Before presenting the data, it is important to consider some of the problems inherent in the use of both metalinguistic and repair data. First, as Levelt et al. (1978) have stressed with respect to metalinguistic data, a large number of studies have confounded children's capacity to make verbal statements with the meta-knowledge they may actually have of linguistic phenomena. Responses may also depend on the different ways in which the child interprets the experimenter's intentions even across tasks which ostensibly tap the same phenomenon (Donaldson, 1978). Direct versus indirect metalinguistic questioning may also affect results. For example, the data from one study, where children were questioned *directly* about their metalinguistic knowledge, suggest that in some tasks it is not until 7 or 8 years and in others not until after 11 years that children consistently accept articles and other functors to be "words" (Berthoud-Papandropoulou, 1978, p. 62). Yet, in a study aimed at analysing factors influencing on-line processing of connected discourse in real time, but *indirectly* also tapping metalinguistic knowledge, it was demonstrated that much younger children have some knowledge of a notion as complex as a "sentence" (Tyler, 1978; Tyler & Marslen-Wilson, 1978). Subjects were asked to listen to a story and, at a key point, "to repeat the last sentence heard". Children as young as five years reproduced the *whole* sentence and not merely, say, the last main clause (which the child could have considered as a "whole" both syntactically and semantically). At first sight it seems counter-intuitive to maintain that 5-year-olds have at some level knowledge of the complex notion of "sentence" whereas 10-year-olds still do not know that "the" is a word. Yet this developmental gap may be real and have less to do with the *possession* of the knowledge of a particular linguistic concept, but rather with the way in which such knowledge is *represented* and *accessed*.

I have addressed this issue previously in problem-solving studies outside the realm of language acquisition (Karmiloff-Smith, 1984 and references therein) which brought out the psychological relevance of hypothesizing different levels of representation and accessing knowledge. This goes beyond the more patent difference, referred to above, between indirectly tapped linguistic knowledge and its directly tapped conscious verbalization. Amongst the problem-solving tasks, one involved asking children first to balance a series of blocks separately on a narrow support and subsequently asking them to build a house with the very same blocks. In the block-balancing part of the task, 6- and 7-year-olds (within a population of 4–9-year-olds) resolutely tried to balance each block at its geometric centre even though many of the blocks were unevenly weighted and their centre of gravity was situated well away from the geometric centre of the block. However, the very same children were successful in balancing all the blocks when this was part of their house-building goal. My interpretation of this, and of analogous data from a spatial task, is that when children's focus of attention is on the *goal* of balancing each block, they access knowledge defined representationally in E-ii or E-iii form (e.g., that objects balance in the middle). However, when the same children's focus is on another goal, i.e., house-building, which is what gets accessed in E-ii or E-iii form, then the balancing of the blocks is simply the *means* to reach the goal and can be accessed in I or E-i form. In the latter case, children's (false) theories about blocks always balancing in the middle do not intrude in the running of procedures which contain the proprioceptive knowledge which younger children use and which allows the older children, in the case of the house-building goal, to balance even the blocks with unevenly distributed weight.

I submit that similar considerations can explain the contrasting results of studies tapping children's linguistic awareness. If an experimenter focuses the child's conscious attention on the *direct goal* of deciding whether X is a sentence or Y is a word, the young child may try unsuccessfully to access knowledge which has not yet been redescribed in consciously accessible form. Thus correct responses may turn out to be a late achievement, irrespective of whether the child is asked for a verbal justification or not. By contrast, if an experimenter focuses the child's conscious attention on the goal of *repetition* of, say, the last sentence or the last word heard at a key point in a story, then understanding what a "sentence" or a "word" is constitutes the *means* to reach the goal and can thus be accessed at the level of E-i or I-represented information, i.e., not yet accessible to consciousness. In this case, the child's conscious access of explicitly represented information concerns the goal, i.e., repetition, and not the means, i.e., what a sentence or word is. These two different experimental approaches thus involve for the child different accessing processes, as well as different levels of representational explicitation. It

would thus be wrong to draw sweeping conclusions from direct questioning tasks and maintain that the child has no knowledge represented about categories such as "words", "sentences", etc. Rather, one should test via different approaches for knowledge also represented in E-i (non-conscious) form and adapt the approach to the distinction between means and goal, discussed above. Indeed, it could be that developmental differences in grammaticality judgements and metalinguistic explanations could be explained by this distinction.

More generally, this suggests that knowledge required as a *means* for another goal is not accessed above E-i level, whereas knowledge required for *goals* always involves levels E-ii or E-iii. This general hypothesis is being further tested in current new problem-solving research; only the linguistic implications will be addressed in this paper.

Despite the limitations of direct questioning, it can provide insights into certain aspects of the developing child's knowledge of language. But here, a methodological distinction is called for. On the one hand, investigators may collect metalinguistic data through tasks in which children are questioned outright with a series of items such as "is X a word?", etc. (Berthoud-Papandropoulou, 1978). These data are normally used to provide a description of developmental stages in children's metalinguistic awareness, as an end per se. On the other hand, metalinguistic data may be collected in a more interactive fashion, i.e., by capitalizing on the fact that a child has just used a linguistic procedure, just made a self-repair, etc. and questioning the child immediately about her self-generated behaviour.[4] Such data can be used as one means amongst others of understanding underlying processes. The second approach was the one used for the collection of the metalinguistic data reported on in this paper.

Another methodological problem stems from the actual availability of metalinguistic responses. As with speech error data, their existence can serve to support or reject hypotheses, but lack of data cannot serve to substantiate counterhypotheses. If my metalinguistic data were to have shown that, say, 5-year-olds were capable of referring explicitly to linguistic "systems", then clearly a number of the hypotheses discussed in Section 2 would be invalidated (e.g., that children's spontaneous correct usage initially stems from implicitly represented isolated procedures and subsequently from E-i representational redescription). However, note that the inverse does not hold. When children do not give verbal explanations, we cannot necessarily conclude that the underlying knowledge is absent, because it may be represented

[4]In Karmiloff-Smith (1979a) I drew a distinction between "metalinguistic" and "epilinguistic", but I have glossed over this in the present context, so as not to overburden the reader with terminological distinctions.

in I or E-i form and not yet be rewritten in E-ii/E-iii form for access to conscious verbal reporting. It is different types of repair data which will be used to decide whether knowledge remains implicitly represented or has been explicitly defined in E-i form. However, while repair data can be very suggestive, again little can be adduced from the absence of overt repairs; their quantification must therefore be treated with some caution (see Section 4b).

4. Discussion of the data

The data for this study have been extracted from a lengthy experimental analysis of French-speaking children's gradual construction of a system of plurifunctional nominal markers used for referential and descriptive expressions (Karmiloff-Smith, 1979a). The experiments covered children's production and comprehension of the deictic, exophoric, anaphoric, quantifier and gender-marking functions of determiners. Within these experiments children were also questioned about their explicit awareness of the spontaneous procedures they had just used in production or comprehension. The production/comprehension data were fully analyzed and reported on, but those relating to elicited and spontaneous metalinguistic responses, as well as to repairs, were at that time interpreted rather "anecdotally" in order to illustrate particular theoretical points. It is these data which have now been subjected to formal analysis and discussion in this paper (see Sections 4a, 4b and 4c below).

The data cover a total of 996 responses from children between the ages of 4 and 12 years, covering both metalinguistic responses and repairs. The data presented here do not include responses concerning the gender-marking function of determiners, due to the fact that a certain number of the metalinguistic gender responses might have been influenced by aspects of written language from children's schooling and therefore not spontaneous. The repair data include spontaneous repairs from the same experiments as the metalinguistic responses (Karmiloff-Smith, 1979a) and spontaneous repairs to determiners from a subsequent study of children's narrative productions (Karmiloff-Smith, 1980, 1985). Spontaneous and elicited metalinguistic data cover a total of 514 responses and the spontaneous repair data total 482 responses, making a comparison between the two a valid exercise.

Examples of the three types of data source, with a literal English translation, are given below. Numerous other examples are provided in the main body of the data section. It should be recalled that singular, plural and gender markers exist on the French definite article and possessive adjectives (e.g., le/la/les/mon/ma/mes); that French does not have distinct phonological forms

for "a" and "one" ("un", or the feminine "une", are used for both meanings); and that most adjectives are postposed (as can be seen from the examples below of a spontaneous metalinguistic comment and a spontaneous self-repair).

Spontaneous metalinguistic comment:
6;10 years: tu as pris la chaussure (rising intonation)...j'allais dire la chaussure rouge mais y en a pas deux de chaussures.

you took the shoe (rising intonation in French)... I was going to say the shoe red but there aren't two shoes.

Elicited metalinguistic comment:
Exp: pourquoi tu as dit *la* pomme?
9;7 years: parce que si y avait eu plusieurs pommes, ben j'aurais dit *une* pomme.

Exp: why did you say *the* apple?
Because if there had been several apples, well I would have said *an* apple.

Spontaneous self-repairs
5;1 years: tu as mis le camion bl... un camion bleu au garage.

you put the lorry bl... a lorry blue into the garage.

6;2 years: ...et puis la fi... une fille lui donne un os. (part of a flow of utterances in a narrative)
...and then the gir... a girl gives him a bone.

The above examples are given in the original French with a literal English translation. Most of the examples cited elsewhere in the text are given directly in English translation, since for the metalinguistic analysis it is not the particularities of French morpho-syntax but rather the content of children's responses which is relevant. However, in the discussion of some of the repair data, the original French will be given in cases where subtle differences between French and English are of specific relevance. Otherwise, the direct English translations suffice to give a clear picture of the data.

Whilst the data cover the age range from 4 to 12 years, it is obviously very difficult to obtain metalinguistic comments from the youngest age groups. Nonetheless, the results show that children as young as 4 years can provide a certain number of such responses. It is important to note, however, that the quantification of responses is indicative of general developmental trends, whereas the *lack* of data is not an indication of "error" and, for reasons pointed out in Section 3, cannot be quantified. Account should also be taken of the fact that in some experiments 4-year-olds were not asked metalinguistic

questions and that not all the tasks were presented to the over 9-year-old age groups. Thus no conclusions should be drawn from the precise figures. Rather, general developmental trends will be shown to hold within and across age groups, based on percentage values between the different *types* of metalinguistic responses. The above comments also apply to the analysis of the repair data. The next two sub-sections give a qualitative and quantitative analysis of the metalinguistic and repair data, and the following section provides a comparison of the two data sources.

4a. Metalinguistic data

The data collected from spontaneous and elicited metalinguistic responses are presented in Table 1 and Figure 1. They have been analysed according to five response categories: (a) real world knowledge awareness; (b) extralinguistic object awareness; (c) extralinguistic relational awareness; (d) intralinguistic marker awareness; and (e) intralinguistic system awareness. An explanation and examples of each response category are given below. It should be noted that the data have purposely been classified "blindly", i.e., according to children's explicit, overt statements, rather than according to what might be implicit in them.

It is assumed that the examples under each category are sufficiently explicit to obviate the need to explain the full design of the many experiments involved (see Karmiloff-Smith, 1979a, for full details). Only a brief indication of the types of task is given here. For comprehension tasks, metalinguistic comments were elicited by questions of the following type: "how did you know which one to choose?", "why did you think it was the boy I was talking to?", etc. For production tasks, children were asked questions such as "why did you say *blue car*, and not just *car*?", "why didn't you say *red*?", "why did you correct yourself from *a car* to *the car*?" etc. Care was taken to avoid experimenter suggestions and, whenever possible, the most neutral forms of elicitation were employed.

The five response categories, based on children's overt statements, are defined below. It is essential to bear in mind that the verbal justifications, including inadequate ones, come from children who performed *correctly* on the comprehension and production tasks. Thus, the verbal statements in the metalinguistic responses of many children do not reflect the fact that in the actual performance tasks the children *must* have picked up, unconsciously at least, the *linguistic* clue provided, given the way the experiments were designed.

(a) *Real world knowledge awareness*

Children justified their responses by drawing on their general world knowledge *outside the experimental situation*, of contexts which reminded them in some way of the context in which the experimental referential expression was used.

Examples

Story task: After hearing a short story in the middle of which a singular definite article was used (e.g., "...et puis le garçon il a pris la pomme..."/ "...and then the boy took the apple...", "...et puis le chien il a écrasé la fleur..."/"...and then the dog crushed the flower..."), children were questioned about the number of apples/flowers etc. in the story and how they had discovered how many there were. Typical (incorrect) responses from children in this first category were:

- 5;8 years: lots, one for each of the teachers;
- 6;9 years: there were lots, because there are usually lots of apples in a fruit basket;
- 7;4 years: lots of flowers, gardens never just have one flower.

Playroom task: Children were questioned about which addressee (a boy-doll or a girl-doll) the experimenter was speaking to. The experimental design was such that responses needed to be based both on the number of different (although not traditionally gender-specific) objects in each of the doll's playrooms and on the use of either definite referring expressions (implying that the doll has one X) or indefinite ones (implying that the doll has several X's). Then children were asked how they knew which addressee it was. Typical responses in the world knowledge category were:

- 4;6 years: you must be talking to the boy because boys like to play with cars;
- 5;2 years: the girl, because dolls are for girls.

It should be noted that these gender-specific responses are irrelevant as responses to this task, since both the boy-doll and the girl-doll each had cars and dolls in their playrooms and only the quantity (one *versus* several) of any particular object differed between the dolls. The examples in this first category are clearer when contrasted with those from other categories below.

(b) *Extralinguistic object awareness*

Children justify their responses by making reference to the task-specific object being focused on in the *present context*, rather than to their general world knowledge as in the previous category.

Examples

Playroom task

- 4;11 years: the boy, because it's his whistle;
- 5;7 years: you must have been talking with the boy because he's got a car.

Referent specification task: situation in which the child must specify a particular referent amongst other potential candidates:

- 6;3 years: I said the red book, because it's red;
- 6;5 years: I said closed cars because they are not open.

(c) *Extralinguistic relational awareness*

Children justify their responses by explicitly comparing the *relations* obtaining between objects in the extralinguistic context, and not merely focusing on the specific object being referred to, as was used in the previous category.

Examples

Playroom task

- 7;3 years: the boy, because they've both got balls but the boy he's got three and the girl she only has one.

Referent specification task

- 6;10 years: took the shoe (rising intonation)... I was going to say the red shoe but there aren't two shoes;
- 8;4 years: I said the book because all the other things aren't books, there's just one.

The next two categories are the only ones where children explicitly refer to *linguistic* clues although, as mentioned above, the children whose metalinguistic data are included in this paper must have all *used* linguistic clues to have been able to solve the comprehension and production tasks which were run prior to the metalinguistic questioning.

(d) *Intralinguistic marker awareness*

Children justify their responses by making explicit reference to the linguistic *marker* (e.g., determiner, adjective, etc.) from which the referential clue was taken.

Examples

Story task

- 8;8 years: I knew there was one apple because you said *the* (stressed) apple.

Playroom task

- 7;7 years: you're talking to the girl because you said lend me *a* (stressed) pen.

Anaphoric comprehension task

- 9;5 years: when you say *the* (stressed) pen, it's the one that the girl already touched.

(e) *Intralinguistic system awareness*

Children justify their responses by making explicit reference to other members of the intralinguistic *system* to which the linguistic marker belongs, and not merely to the specific marker, as was used in the previous category.

Examples

Story task

- 9;10 years: you said *the* (stressed) biscuit; if there had been a lot you would have said: he took *a* (stressed) biscuit or *one of the* biscuits.

Playroom task

- 8;7 years: the boy, because he's got several. If it were the girl you were talking to, you'd have said: lend me *your* (stressed) bell, not *a* (stressed) bell, she's got just one.

Anaphoric comprehension task

- 10;8 years: it must be the same boy, because first you said *a* (stressed) boy and then *the* (stressed) boy, so it's the same one.

Referent specification task

- 10;11 years: *my* (stressed) watch because it's mine and *the* (stressed) watch because it's the only one present, otherwise you'll think there's another one.

It should be recalled that children's responses were classified according to explicit, overt statements. According to the model presented here, these overt verbal responses are drawn from representations in E-ii/E-iii form. The reader will have noticed that sometimes a response categorized under, say, awareness of intralinguistic *marker* presupposes some features of the statements categorized under awareness of intralinguistic *system*. Indeed, the formulation of statements falling under most categories presupposes a form of knowledge of aspects of the following category. According to the model presented here, such knowledge is still represented in E-i form and thus inaccessible to conscious reflection. To avoid subjectivity in the analyses, only the overt statement was used to categorize the metalinguistic data. In general, categories (b) and (c) both involve reference to situation-specific knowledge, category (c) being explicit regarding the extralinguistic *relations* involved, and both contrasting with the general world knowledge invoked explicitly in category (a) responses. Both categories (d) and (e) contrast with the extralinguistic categories by the fact that children refer to *linguistic* clues, the former with respect to the linguistic marker, and the latter explicitly invoking aspects of the systemic organization of that marker with other linguistic terms stored in the same sub-system.

Table 1 presents the results of the quantitative analysis of metalinguistic responses as a function of age and type of response category, expressed as a percentage of the total number of responses by age group.[5] The results point to overall developmental changes across category types. Real world knowledge justifications only accounted for a small percentage of responses, predominantly in the very youngest age groups. Moreover, these category (a) responses mainly emanated from the only experiment (the story task) for which there was no physical context. The clue to interpretation (hearing the singular definite article used at a point in the short story) had to be drawn solely from the linguistic context with no extralinguistic support. For these two reasons, the importance of this category is obviously limited, the essential distinction for the present analysis lying between the two extralinguistic and the two intralinguistic categories.

[5]It should be recalled that it is difficult to elicit metalinguistic responses of this nature from 4-year-olds, and that certain tasks were not presented to over 9-year-olds. Thus the total number of responses for the two extremes in the age groups are considerably lower than for other age groups. Percentage values should therefore be treated with caution.

Table 1. *Awareness responses as a function of age and response category, expressed as a percentage of total number of responses per age group*

Age group	Total number of responses per age group	Real world knowledge awareness (Category a) %	Extra-linguistic object awareness (Category b) %	Extra-linguistic relational awareness (Category c) %	Intralinguistic marker awareness (Category d) %	Intralinguistic system awareness (Category e) %
4–4;11	22	13	81	6	0	0
5–5;11	58	2	42	52	4	0
6–6;11	51	3	28	44	22	3
7–7;11	97	1	6	53	35	5
8–8;11	108	1	7	52	25	15
9–9;11	105	0	1	15	36	48
10–10;11	37	0	3	6	54	37
11–12;5	36	0	3	0	19	77

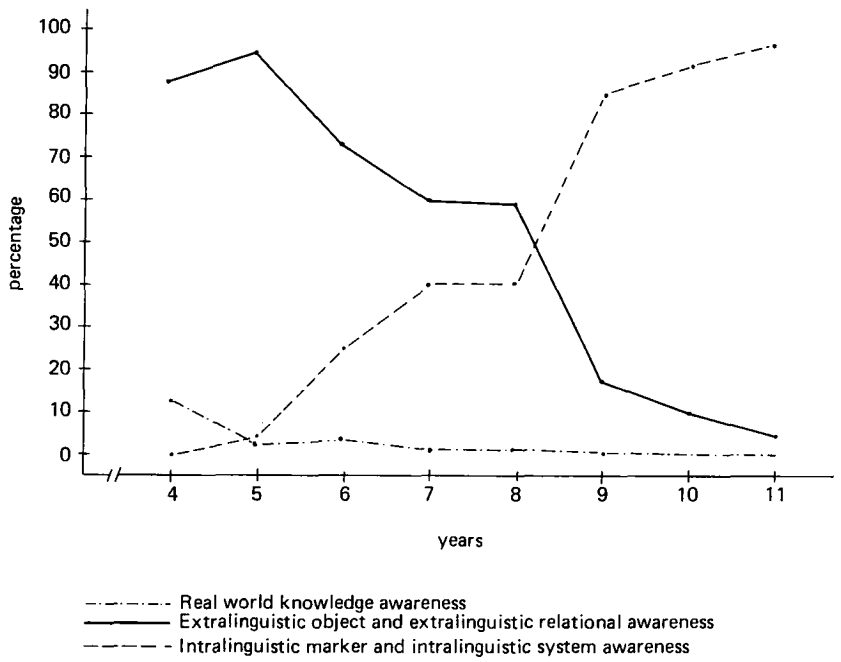
Awareness responses for gender experiments are not included.

As can be seen from Table 1, extralinguistic object awareness (children focusing on features of a specific object) is predominantly found as a metalinguistic explanation as of 4 years, and practically disappears as of 7 years. Extralinguistic relational awareness accounts for approximately half of children's responses between 5 and 8 years, with a sharp downward trend as of 9 years. Explicit reference to the intralinguistic *marker* begins to appear in a certain number of responses around 6 years, but it is not until 9 years onwards that a substantial number of children explicitly invoke the intralinguistic *system* as a metalinguistic justification.

Figure 1 presents the metalinguistic results graphically, grouping together the two extralinguistic categories and comparing these with the two intralinguistic categories. The figure highlights the gradual progression at around 8 years from extralinguistic awareness to intralinguistic awareness.

Were this paper concerned with metalinguistic awareness per se, the conclusions could begin at this point. A description could now be made of the developmental stages involved in moving progressively from the younger child's awareness of the mapping between a linguistic expression and its relevant extralinguistic context, to the older child's awareness of the intralinguistic system. And, as other investigators concentrating on age-related sequences have done, I could point to the developmental gap which exists between successful comprehension/production and awareness. But my intention is to address the question of the *function* of metalinguistic awareness in

Figure 1



the process of development. However, given the tenuous nature of metalinguistic data, discussed in Section 3, one might question whether metalinguistic data can be used for gaining insight into language acquisition processes, rather than merely cataloguing the development of metalinguistic capacities per se. I contend that the use of metalinguistic data in this way is only a valid exercise provided other data exist which point in the same explanatory direction. In this paper, metalinguistic data are used to provide evidence of underlying representational processes also discernible, although less directly, from other data, i.e., spontaneous repairs, to which we now turn.

4b. Repair data

For the analysis of the repair data, I am invoking a distinction drawn earlier (Karmiloff-Smith, 1979a, pp. 45–54) between two functions of linguistic terms such as articles, modifiers, possessive adjectives, etc. The functions are: (a)

the "descriptor function" (providing more information than necessary, such as colour, size, spatial location, etc., about a focused-upon referent, when in fact the noun alone would suffice to identify the referent) and, (b) the "determiner function" (providing spatial, colour, size information which is essential to enable the addressee to pick out a referent amongst other potential candidates).

The 482 spontaneous repairs are sub-divided into three categories. Each of the categories is explained below, together with some examples of children's repairs. Additional examples of repairs are provided in the subsequent comparison of the different repair categories, exemplifying each category by the same linguistic terms: size/colour adjectives, articles, and the first person possessive adjective. Finally, Table 2 and Figure 2 set out quantitative data as a function of age and repair category. The three categories are as follows:

(i) Repairs to the descriptor function of articles, adjectives and possessives: these repairs involve the addition by the child of information about the specific referent, but where the additional information is redundant with respect to identifying the referent, although it is *not incorrect.*

Examples

- 4;3 years: you put the church... the tiny little church into the tin
  (context with only one toy church)
- 4;8 years: ...and then the boy... the little boy in red went home with his balloon...
  (middle of a story with only one boy)
- 5;1 years: you took away the hairclip... my hairclip
  (context with only one hairclip)

(ii) Repairs to errors with respect to the determiner function of articles, adjectives and possessives, generated by a sensitivity to the mapping between linguistic markers and the particularities of the referential context:

Examples

- 4;9 years: you hid the book... a book
  (context with several books present)
- 5;2 years: lend me the ball... the green ball
  (context with different-coloured balls present)
- 6;4 years: you have to put the red... my red cars in the garage
  (context where there are red cars on both the child's and experimenter's parking lots, but in which only the child's red cars should be put in the garage).
  N.B. that both the definite article and the possessive adjective are marked for the plural in French: les/mes.

- 6;6 years: ...and so he asked the man for a balloon...the green one... (part of a narrative in which there is one green balloon amongst other non-green ones)

(iii) Repairs to the determiner function of articles, adjectives and possessives, generated by a sensitivity to the systemic organization of linguistic terms and to gauging the referential force of various terms within the same sub-system. These repairs are *not* corrections of errors. In every example falling under this category, the utterances could have been left unrepaired and would have still been totally unambiguous for the addressee to pick out the correct referents.

Examples

- 5;10 years: the open and closed cars... the cars must go to the garage, all of them
  (context where all the cars are placed in the garage and only open or closed cars exist in the game, so that "the open and closed cars" could have been left unrepaired)
- 6;3 years: ...and then fortunately the girl... a girl offers the dog a bone
  (in the context of a narrative, although this is the first mention of the girl, the use of the definite article could have gone unrepaired, given that there is only one girl in the story and both interlocutors are looking at the book together)
- 6;7 years: you hid a cup... the cup
  (context where only one cup is physically present and which had not been mentioned in prior discourse, so that "you hid a cup" could have been left unrepaired)
- 7;1 years: my watch... the watch should be put in there
  (context where only the child's watch is present, so that the possessive need not have been repaired)
- 9;1 years: my yellow cars... the yellow cars must be put in the garage
  (context where yellow cars exist only on the child's parking lot and not on the experimenter's, so again the possessive need not have been repaired)

From these examples of each repair category, the following should be borne in mind:

- category (i) involves the addition of correct descriptive information but which is redundant with respect to identifying the referent;
- category (ii) involves adding or correcting information so as to make an underdetermined referential expression appropriate for the unambiguous identification of the intended referent;

- category (iii) involves the deletion and repair of correct information which, had the child not made the repair, would have still enabled the addressee to identify the referent unambiguously.

Repair category (i) is not of particular relevance to the arguments pursued in this paper and, as will be seen later in the quantitative analysis, only accounts for a small percentage of responses. An interpretation of repair categories (ii) and (iii) is discussed below, contrasting each category by taking examples from the same linguistic terms: first, the use of colour adjectives, then that of definite/indefinite articles and, finally, the use of the first person plural possessive adjective and the plural definite article. The examples are given in the original French, with a literal translation in English, given that intonation, word order etc. in French offer clues to underlying processes in a somewhat different way as compared to English.

The first set of examples are taken from colour adjectives. Adjectives may provide *essential* referential information in a particular context (e.g., where the context contains several objects from the same class but which differ in colour, and where only one of them is hidden). In a different context, colour adjectives may provide redundant, *but not incorrect*, information (e.g., when the hidden object is a singleton in its class, there is no need to mention its colour, although it is not an "error" to do so). Repairs in the adjective category are discernible from pauses, deletions, additions and intonation patterns in French. Recall that colour adjectives are postposed, e.g., "le canard rose" = "the pink duck" (literally, "the duck pink"). Normally there is rising intonation on the noun if the French speaker intends to follow it with an adjective, and falling intonation on the noun if the speaker does not intend to add an adjective. Hence French intonation patterns give clues to repairs even in cases when no partial output of an adjective or no pause are detectable.

The first two examples below from colour adjective repairs fall under category (ii) of repairs that are corrections to inadequate referential information. They contrast with examples (c) and (d) which fall under repair category (iii) where outputs could have remained unrepaired for correct identification of the extralinguistic referent.

Example (a)

- 5;8 years: tu as enlevé le lit (falling intonation and pause)...bleu
  you took away the bed...blue
  (context with two beds of different colours)

Example (b)

- 5;10 years: tu as caché le poisson (falling intonation, no discernible pause) vert
  you hid the fish green
  (context with two fish of different colours)

Example (c)

- 4;7 years: mets les camions (rising intonation) bleus et rou...les camions (falling intonation) dans le garage
  put the lorries blue and re...the lorries in the garage
  (context where all the lorries are to be put in the garage and all lorries are either blue or red)

Example (d)

- 6;11 years: tu as caché le canard (rising intonation) rose...le canard (falling intonation)
  you hid the duck pink...the duck
  (context with only one duck)

It should be recalled that when children in category (i) repair by adding an adjective, they do so when the referent is alone in the context. This shows that they are not yet sensitive to the fact that the adjective sometimes provides *essential* referential information, and at other times does not, i.e., when used in its descriptor function. In contrast, in examples (a) and (b) above from category (ii), the children add the colour adjective because there is more than one possible referent identified by the noun alone, and therefore the adjective provides essential referential information to distinguish between relations obtaining in the extralinguistic context. These data from responses in category (ii) demonstrate that, although the surface output is like category (i) responses, i.e., repair by the addition of an adjective, category (ii) subjects are now sensitive to the mapping between particular linguistic markers, such as adjectives, and the extralinguistic context in which the referential expression is used.

In contrast with the first two examples, examples (c) and (d) show that children in category (iii) will *delete* an adjective, even though it correctly describes the referent. The deletion of adjectives, despite the fact that the initial output with the adjective would allow the addressee to identify the referent unambiguously, represents an eloquent demonstration that children in category (iii) are sensitive to the implications of both the use and the non-use of adjectives. Thus, for these children, when a colour adjective is used in its determiner rather than descriptor function, this use necessarily implies that other objects from the same class (but of different colours) are present. They therefore delete the (albeit correct) descriptive adjective to avoid such implications.

In general, I would argue that the category (iii) child's repair by deletion of the correct descriptive adjective shows that she or he has developed a *system* of explicitly related functions which adjectives can assume, and is thus sensitive to the fact that the *non-use* of the adjective also carries information.

I submit that if, and only if, a speaker is operating on systems of explicitly related representations, and not on independently represented entries, then what is left unsaid is as informative as what is actually said. Children's deletion of a linguistic marker—despite the fact that it correctly describes the referent—is a telling indication of the plausibility of this hypothesis.

The second set of examples is taken from spontaneous repairs which occurred in experiments dealing with the definite/indefinite article contrast. As argued elsewhere (Karmiloff-Smith, 1979a) the word "contrast" entails theoretical assumptions that may not correctly reflect the child's underlying representations. For adults, articles can be used contrastively as part of the same system. But it takes time developmentally before the articles in fact become explicitly linked. My argument is that, initially, prior to the emergence of repairs, children's correct use of each of the articles stems from two independently represented procedures.

In the examples which follow, the first two fall under category (ii), i.e., corrections to the determiner function of the articles, and the last two under category (iii) where the output could have remained unrepaired with respect to identification of the referent. They are given here directly in English translation since the differences between English and French are unimportant in this particular context.

Example (e)

- 4;7 years: you put the rabbit... (pause) a rabbit into the box
  (context where another rabbit had already earlier been placed in the box)

Example (f)

- 4;10 years: I think you hid the b... (pause) a ball
  (context where 2 balls were present)

Example (g)

- 6;2 years: you took a blo... (pause) the block
  (context with only one block present)

Example (h)

- 7;5 years: you put a pen... (pause)... *the* (stressed) pen into the box
  (context with only one pen present)

In examples (e) and (f), which fall under category (ii), the repair involves a correction of an *error*, because the objects are not singletons in the extralinguistic context. The use of the definite article conveys the wrong information. By correcting to the indefinite article, children show sensitivity to the need for correct mapping between a particular linguistic marker and the relations

of the referent to other objects in the context. Examples (g) and (h), by contrast, are revealing in that the original use of the indefinite article is *not incorrect*, even if the objects are singletons. Had the children left the utterances unrepaired and said: "you took a block" or "you put a pen into the box", this would have unambiguously identified the referent. In these examples, the mapping between the linguistic expression and the extralinguistic referent is not incorrect. My argument is that this type of repair is only explicable if one hypothesizes that children in category (iii) are sensitive to the presuppositions implied by the use of each article *and* to its intralinguistic relationship to the other article. Children are henceforth operating on explicitly defined links across the representations of the articles which had previously been independently represented. Recall with respect to the previous set of examples, that children in category (iii) deleted adjectives even though they correctly identified the referent. Children at this level denote their sensitivity to subtle presuppositional information that can be conveyed by the use and by the *non-use* of particular markers, once they have become explicitly linked. In these category (iii) cases and those to be discussed below, the repairs were not triggered by errors in the form of the utterance or its appropriateness for unambiguously identifying the extralinguistic referent. The utterances do, of course, violate Gricean maxims but, and this is one of my essential arguments, for children to be sensitive to such maxims, their linguistic representations cannot remain independently stored but links between them must have become explicitly defined.

The third set of examples covers a broader system than the functions of adjectives or the article contrast, and demonstrates how the explicitation of relationships between forms progressively enlarges. The examples are taken from an experiment testing children's production in French of the plural definite article "les" and the first person plural possessive adjective "mes".

It is necessary to give brief details of the experimental design (see Karmiloff-Smith, 1979a, for full details), to clarify the examples discussed below. There were two parking lots, one belonged to the child, the other to experimenter-II. There were cars and lorries on both parking lots, some of which were duplicated and some (e.g., yellow cars) were only to be found on the child's parking lot. Experimenter-I placed a certain group of vehicles in the garage. Experimenter-II could not see what experimenter-I had done. The children's task was to give instructions to experimenter-II about the vehicles now placed by experimenter-I in the garage, so that experimenter-II could, when he opened his eyes, place exactly the same vehicles in the garage as those just removed. Children could refer to all the cars on their own parking lot as "mes voitures" (my cars) and to all the cars from both parking lots as "les voitures" (the cars). Note that in contrast to English the plural is audible

in French on the determiners (les/mes) and not audible on the nouns used in this experimental task (the "s" on "voitures" and "camions" is not pronounced). Examples will be given in the original French, with a literal English translation. The experimental design was such that for some items (e.g., lorries, red cars, etc.), the child is obliged to distinguish between the definite article and the possessive adjective, depending on whether the vehicles came from both parking lots or just from the child's. By contrast, where vehicle types only exist on the child's parking lot (e.g., yellow cars) which have no duplicates on the experimenter's lot, the child could refer to them as "my yellow cars" *or* "the yellow cars". In either case, the utterance would unambiguously identify the referents for the addressee. Below are examples of children's spontaneous repairs, the first two falling under the category (ii) and the last three under category (iii):

Example (i)

- 4;10 years: tu dois mettre mes voitures rou... non, les voitures rouges dans le garage
  you must put my cars re... no, the cars red into the garage
  (context where all the red cars from both parking lots have been put into the garage)

Example (j)

- 5;6 years: il faut bouger les camions (rising intonation) ...mes camions bleus
  you must move the lorries... my lorries blue
  (context where only the child's blue lorries had been put into the garage, but where blue lorries existed on both parking lots)

The context for all of the next three examples was identical: yellow cars only existed on the child's parking lot:

Example (k)

- 7;7 years: c'est mes...euhm...les voitures jaunes qui doivent aller au garage
  it's my...uhm...the cars yellow which must go to the garage

Example (l)

- 8;2 years: les ... (pause) ... mes voitures jaunes ... les voitures jaunes ... les miennes
  the ... (pause) ... my cars yellow ... the cars yellow ... mine

Example (m)

- 9;1 years: mes voitures jaunes ... (pause) ... les voitures jaunes doivent être mises au garage
  my cars yellow ... (pause) ... the cars yellow must be put into the garage

Examples (i) and (j) above show that children are sensitive to the need for adequate mapping between the linguistic marker and the particularities of the extralinguistic context. These category (ii) repairs involve corrections of errors, since without the repair the addressee would have placed the wrong vehicles in the garage. By contrast, examples (k), (l) and (m), like the category (iii) examples discussed for adjectives and articles, could have remained unrepaired. Had the addressee received the instruction "put *my* yellow cars into the garage", this would have identified the referents unambiguously. The repairs clearly go beyond the desire for adequate mapping between a linguistic marker and the extralinguistic context, since the unrepaired version already satisfies such a criterion. These category (iii) examples are again an eloquent demonstration of children's sensitivity to the presuppositional information conveyed by the subtle contrasts between forms which must have become explicitly linked within an expanding linguistic sub-system.

Example (l) above is a particularly nice illustration of conflict between, on the one hand, providing the descriptor information (my/mine) and, on the other hand, trying to use a referring expression with the right presuppositional force that does not imply the presence of yellow cars on the experimenter's parking lot. Examples (k) and (l) are direct repairs without the sign of conflict, and for these children the systemic restructuring of this particular part of the determiner system is probably stable.

It is interesting to see a somewhat similar conflict (although resolved as the child proceeds) arising during *explicit* metalinguistic awareness responses. The example, given directly in English translation below, is from a precocious 9-year-old, well in advance of her age group in all the different tasks:

> 9;3 years: It's because "the" is shorter, it's not true for the number of letters ("les" = "mes"), but it's just as if...I can't quite explain, but you can say both "the" or "my", but if there (points to the experimenter's parking lot) there were some yellow ones, then one would be obliged to say "my", but there aren't any there, so it's better to say "the yellow cars" even if they belong to me.

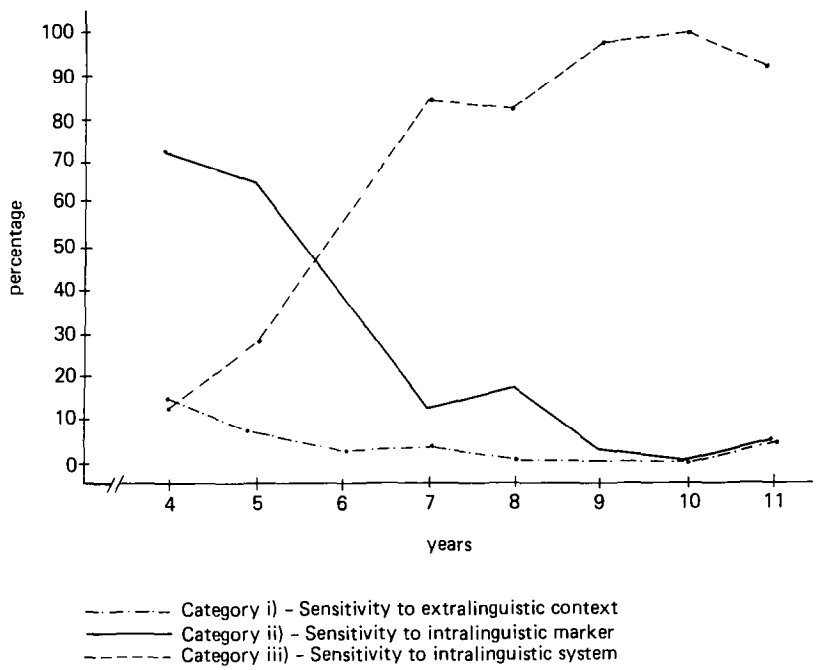
Such eloquence in a metalinguistic response is rare, but the overt statement reflects what is underlying children's spontaneous repairs such as in example (m) discussed above. What is clear from the metalinguistic statement, and indirectly from the repairs, is that the use of the possessive determiner is not considered by the child to be an "error" with respect to the identification of the extralinguistic referent per se. Rather, the child is gauging the subtleties of the intralinguistic presuppositional information that can be conveyed by different terms which are explicitly linked within the same sub-system.

Prior to discussing the relationship between the metalinguistic and repair data in Section 5, the quantitative results of the repair data are given below

Table 2. *Repair data as a function of age and response category, expressed as a percentage of total responses per age group*

Age group	Total number of responses per age group	Category i—repairs to the descriptor function of markers (addition of redundant information) (Category i) %	Category ii—repairs denoting sensitivity to linguistic markers (Category ii) %	Category iii—repairs denoting sensitivity to linguistic systems (Category iii) %
4–4;11	54	15	72	13
5–5;11	75	7	65	28
6–6;11	71	3	39	58
7–7;11	83	4	12	84
8–8;11	73	1	17	82
9–9;11	62	0	3	97
10–10;11	37	0	0	100
11–12;5	27	4	4	92

Figure 2



in Table 2 and Figure 2. It is important to recall that the sort of repair discussed in this paper occurs developmentally later than correct, unrepaired usage (see also Bowerman, 1982, for late occurring errors after correct output in the semantics of verbs, and Newport, 1982, for similar phenomena with respect to the morphological markers of American Sign Language). Table 2 shows the distribution of 482 repairs by age and type of repair category, expressed as a percentage of total repairs per age group. Figure 2 presents the distribution of the three repair categories graphically. It can be noted that very few repairs occurred at any age for category (i) in which children repair by the addition of redundant referential information, merely giving a fuller description of the focused referent. (Note that many young subjects did provide considerable amounts of redundant information in my various experiments, but the above data only concern utterances which were repaired.) Table 2 and Figure 2 show that very young children—4- and 5-year-olds—are already sensitive to the mapping between a particular linguistic marker and the extralinguistic referent, i.e., category (ii) repairs. And, in a fair number of cases as early as 5 years and clearly as of 6 years, children's repairs reflect sensitivity to the presuppositions of different terms explicitly linked within the same linguistic sub-system.

4c. Comparison of children's metalinguistic responses and repairs

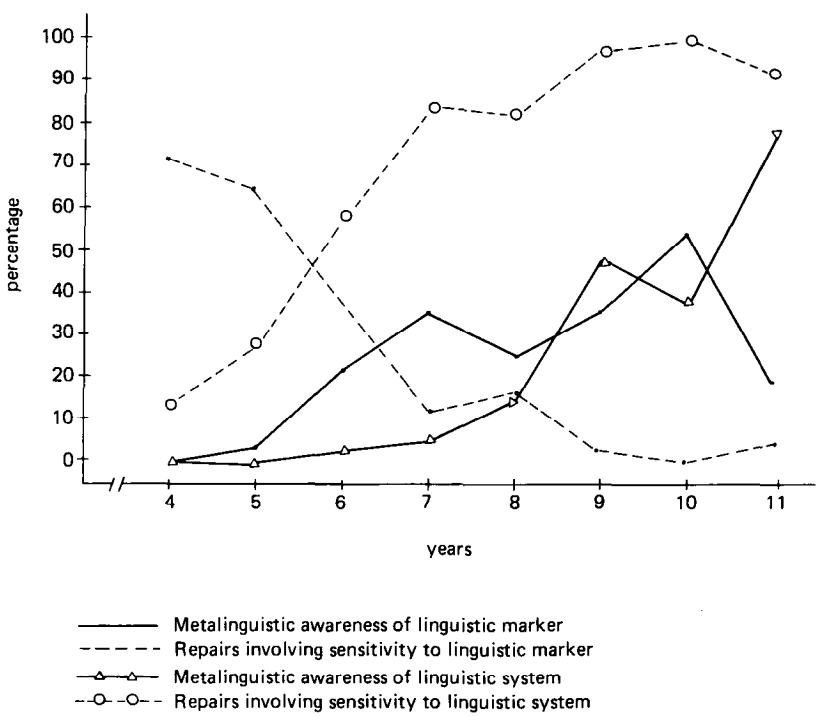
Earlier in this paper, I argued that the notion of "*meta*-processes" should be an essential part of any psychological model of human development, but that I would not restrict "meta" to verbally encoded conscious access. I submit that metaprocedural processes can, and very often do, occur *without* conscious metacognitive reflection. The problem of how to gain insight into meta-processes without relying on verbalized statements about awareness is solved, in my view, by the subtleties revealed from the repair data. The discussion in Section 4 shows that repairs reflect metaprocedural processes—in this case the progressive explicitation of representational links across the linguistic forms—in an indirect, spontaneous way, by comparing different types of repairs concerning the same markers. None the less, the metalinguistic data are also relevant since they spell out overtly what is hypothesized to underlie children's repairs.

The results from both data sources show similar developmental patterns. In the two cases, young children become progressively sensitive to or aware of the mapping between linguistic markers and extralinguistic contexts; later in development the sensitivity to or awareness of the presuppositional potential of markers explicitly linked to form linguistic systems can be discerned from children's repairs and judgements. However, what remains to be

explored is whether the ability to have conscious access to metalinguistic knowledge is a necessary prerequisite for the formation of linguistic systems. In other words, do the repair data follow or precede developmentally children's accessible metalinguistic knowledge? In order to address this question, it is not sufficient to demonstrate similar developmental trends of category types for each data source. Rather, it is necessary to make overall comparisons of age group trends for the repair and metalinguistic data.

Figure 3 plots a comparison between the results from the metalinguistic and repair data with respect to linguistic markers and linguistic systems. Although one must bear in mind the precautions mentioned in Section 3 with respect to the comparisons of this type of data, the figure none the less highlights the huge developmental gap which exists between children's spontaneous repairs and their conscious access to verbally encoded representations. Repairs denoting sensitivity to the *system* are from the outset well in

Figure 3



advance even of the less complex category of awareness of *markers*. The comparison of the repair and metalinguistic data demonstrates that the child can move through the total development of explicitly defining links between independently represented form–function pairs, without any need for conscious access.

Within the model developed here, these comparisons suggest that children initiate and complete their metaprocedural operations on E-i representations, well before they are able to have conscious access to the corresponding metalinguistic knowledge in E-ii/E-iii form. Thus conscious verbal report reflects, rather than guides, internal representational change.

5. Concluding discussion

The analysis of the repair and metalinguistic data substantiated the plausibility of several aspects of the model regarding implicitly defined representations and their progressive explicitation. Note that there are no explicit relations or systems *in* the input that the child hears. The input model presented to the child only defines such potential links implicitly, in the very sense that I have used "implicit" in the present model. It is thus via endogenous processes, i.e., children's spontaneous (albeit unconscious) work on linguistic representations as a problem space per se, that they can establish representational links and restructure certain memory entries into linguistic sub-systems. Metalinguistic awareness is not a necessary prerequisite for this, but the end-product of representational explicitation. Similar conclusions regarding the non-necessary role of metacognitive awareness can be drawn from other studies outside language, e.g., the comparison between children's successful use of memory strategies and their metamemory awareness (Cavanaugh & Borkowski, 1980). But children do ultimately have conscious access to the product of the processes establishing representational links during the 3-phase cycles. What, then, is the function of verbally-encoded metacognitive awareness? Is metalinguistic awareness merely epiphenomenal on language acquisition (in Marshall and Morton's 1978 terms, a "cognitive optional extra") or is there a relationship between metalinguistic awareness and the unconscious meta-processes involved in the complex cycles of representational change? Why do children ultimately have conscious access to knowledge about certain aspects of language and not others?

My conclusion is that metalinguistic awareness has little or no role to play macrodevelopmentally in *language* acquisition. This seemed clear from the developmental gap between usage, repairs and conscious access. Metalinguistic awareness may have a minor role to play in behavioural changes in on-line

linguistic processing, but above all I would submit that the verbal encoding of linguistic knowledge has an essential role to play, not in language acquisition, but in representational change in overall macrodevelopment. Let us see what this implies.

Reconsider the different levels of progressive explicitation of representations, specified in Section 2, but in doing so bear in mind the fundamental difference between a model of developmental sequence involving representational change outside input/output relations, as proposed here, and a non-developmental model of on-line processing in real time, i.e., during input/output relations, as proposed for example in the Marshall/Morton model discussed in Section 1. In the case of on-line processing, a negative feedback loop seems to be important to provoke conscious access, and the content of that consciousness must, according to my model, be a representation already redescribed in E-ii/-iii form. The on-line processing account attempts to stipulate *when*, in the information flow, a consciousness operator is called. By contrast, in the case of a model of developmental sequence, the theorist is trying to explain *how* representations become progressively accessible to consciousness macrodevelopmentally. In this respect I have argued that in accounting for representational change macrodevelopmentally, an important role must be conferred on positive feedback loops, and that the content of consciousness is the result of a complex process of representational redescription and explicitation.

In the present model, consciousness is the highest level developmentally of representational explicitation. This is not, however, contradictory with the argument put forward by Shallice (1978) that consciousness is not necessarily at the top of a processing hierarchy when called on in real-time. This again stresses the need for caution when comparing information processing models with models of macrodevelopmental sequence.

In the Marshall/Morton on-line processing model, the consciousness operator is an all-or-nothing, built-in process which operates every time the system encounters failure. Were such reasoning applied to a model of macrodevelopmental sequence, it would leave unexplained why children go beyond successful output and why there exists a developmental gap between usage and conscious access. If a consciousness operator were constantly ready to function, why would it take so much developmental time for children to gain conscious access to the linguistic representations already being efficiently used? In the present model, by contrast, consciousness is an emergent property of the overall cognitive system and of its processes of gradual representational explicitation. What other implications does the model have? The notion of an initial level of linguistic procedures capable of outputting a plethora of correct forms may lead to a rethinking in developmental

psycholinguistics of the definition of "productivity", since consistent correct usage of a form could be based solely on large numbers of independent I-representations. The model may also have implications for subnormality. Cromer (in progress) is carrying out some fascinating studies of hydrocephalic children in whom very low IQs coexist with amazingly fluent, seemingly complex language production. Can the 3-phase model, and the various theoretical notions embedded in it, provide clues to the *representational* status of such children's fluent language? In my view, it would be worth exploring the hypothesis that such children's language is learned solely via innate syntactic constraints and, for lexico-morphology, via processes at work in phase 1 which do not involve representational redescription and explicitation. This would predict that the output of such children would *not* show the type of repair denoting sensitivity to linguistic markers/systems discussed here nor, ex-hypothesis, would they have metalinguistic knowledge of such markers/systems. This would not preclude, however, that they might be able to provide extralinguistic awareness statements if their non-linguistic cognitive development had undergone representational redescription, although their IQs would make this seem highly unlikely. The model would also predict subtle differences in the linguistic organization of their spans of extended discourse (notwithstanding referential adequacy), if their discourse markers had not undergone explicit definition and been restructured into systemic groupings.

We are left with a further question regarding normal acquisition. Why is it that children progressively have access to the products of representational explicitation and the components of systemic groupings, but that they do not seem to have access to the dynamics of the *choice* within systems of discourse markers in on-line production of spans of sentences? Indeed, the choice between different, closely related discourse markers, operative in extended spans of spoken discourse (Karmiloff-Smith, 1985), do not seem to be available for conscious inspection to older children or even to adults (except in the case of the researcher who takes the fast-fading dynamic of spoken text and "freezes" it, i.e., translates it into the static code of the written form, in order to make a detailed discourse analysis possible). In a recent pilot study I have shown that both older children and non-linguist adults not only cannot explain why they choose to use a pronoun, a full noun phrase etc. at a particular point in the flow of discourse but also, in a repair detection task, they have far more difficulty in detecting repairs that are discursively rather than semantically relevant. In other words, they successfully detect a repair from "he" to "she" involving a semantic error of gender, but they often edit out, or take far longer to detect, repairs *not* involving errors with respect to the identification of the referent. And even when such repairs are detected, adults and older children give (incorrect) ambiguity explanations for the re-

pairs rather than discourse organizational ones.

Whilst the pilot study needs to be substantiated by a fully fledged experiment, the initial results suggest that indeed some aspects of language are available to consciousness whereas others are not. Older children and adults, although able to provide complex metalinguistic statements about some aspects of language, seem to have no access to the decisions made with respect to choices amongst systemically organized representations in a span of discourse. To speculate within the present model, these specifically discourse choices, which can occur developmentally only once representational redescription, explicitation and restructuring have taken place, may become modularized as a *product* of development. Hitherto, discussions of modularity have focused solely on innate modules (e.g., Fodor, 1983). I endorse the notion of certain domain-specific innate modules, as well as more general central processes. It has been further suggested that some of these modules may become less encapsulated with development (Keil, 1986; Rozin, 1976). My additional hypothesis runs as follows: in the human cognitive system, consideration of modularity should not be solely restricted to innate givens; modularity can also arise developmentally as the *product* of constructive processes.

Candidates for modularity as a product of development are those aspects of language where, after a lengthy developmental process of representational explicitation and restructuring, the feedback from each decision regarding the choice of a discourse marker becomes the input for the generation of the next choice, i.e., a closed loop control. It is the fast-fading nature of spoken language and the constraints of real-time processing which necessitate the use of specific discourse information beyond the semantic information conveyed (Karmiloff-Smith, 1985). This naturally involves a trade-off between occasional selection errors from systemic groupings and the necessary rapidity of on-line repairs as a result of gauging the discourse structure. Conscious access to such a system would interfere with such rapid processing. It is thus plausible to speculate that, after the lengthy process of representational redescription, explicitation and restructuring, operations on discourse-marking systems are ultimately modularized. Therefore, whilst representational links and systemic groupings get later redescribed in E-ii/E-iii form, the decisions governing choices amongst markers within a systemic grouping are not available to conscious access. Furthermore, if one considers the on-line choice of sentence structure (relative clause, passive, etc.) in part as a discourse phenomenon (Karmiloff-Smith, 1985), then this may explain why these, too, are not, according to Slobin (pers. comm.), available to conscious access. The framework may thus be useful in considering second language learning in adults, from a representational viewpoint. For instance, why is it that fre-

quently the interplay of discourse markers (use of articles/verbal morphology) is the very area which distinguishes the native speaker from the fluent non-native speaker who has learned the language as an adult? If operations on the sub-systems of discourse markers involve specifically linguistic modules, as argued here, then these might be subject to the same maturational constraints regarding age of acquisition, as is the case for phonology in a foreign language. By contrast, the explicit defining of representational links, which is a more general cognitive process, would not be subject to this domain-specific constraint and this would allow for the subtle semantic modulations that fluent second language users do display.

Is representational redescription essential for the child to be able to encode knowledge verbally? Clearly not. One could seemingly short-circuit the 3-phase cycles and representational redescription. Research on children's arithmetic knowledge is an eloquent example of this. Children can learn from a teacher a series of verbally encoded principles which they can repeat perfectly. Yet the procedures that these same children use for arithmetic problem solving violate these very principles (Hennessy, 1986). In other words, for the child, there is as yet no connection between the two; the verbally encoded principles are not the end-product of internal representational explicitation but learnt directly from an external source. The verbally encoded principles have not therefore been linked *representationally* to the arithmetic procedures used in problem solving. It follows that they could not yet act as a constraint on the latter.

I argued above that verbally encoded representations of linguistic knowledge had little or no role to play in language acquisition, but a fundamental function in overall macrodevelopment. My argument is that once kinaesthetic, spatial and temporal representations, as well as representations of linguistic knowledge, are re-represented in a common code, this would allow for the explicit defining of representational links to operate across the cognitive system. It thus follows from the model that *unconscious* metaprocedural processes could operate on the representations of *conscious* inter-domain metacognition, thereby defining in E-i form new connections which remained implicitly defined for as long as the representations were in different codes. This suggests *how* the total cognitive system might gain access to knowledge originally limited to specific functions within a particular representational code. Ultimately such explicitly defined links could be redescribed in E-ii/E-iii form and be available to conscious access. But once again, this takes developmental time (for the child, as well as for the adult, e.g., in scientific discovery, as new knowledge is added to the cognitive system). Multiple representations of the same knowledge in different codes and its gradual re-representing in one and the same code open the possibility of an ever-increasing flexibility and creativity in the human cognitive system.

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Résumé

Cet article étudie les relations possibles entre meta-processus inconscients et meta-processus accessibles à la conscience et au compte-rendu verbal. Le point de vue défendu dans cet article est que la question de l'accès conscient doit être conceptualisée dans la perspective du développement si l'on veut comprendre sa fonction

dans la cognition humaine. Un cadre théorique est proposé, sous la forme d'un modèle récurrent à trois phases (différent des modèles conçus en termes de stades) qui distingue les représentations définies de manière implicite et plusieurs niveaux d'explicitation progressive dont l'aboutissement est la possibilité de l'accès conscient. Le rôle de l'accès conscient, ainsi que celui du feedback positif et négatif, est discuté à la lumière d'une distinction entre modèles du développement et modèles de traitement de l'information en temps réel. L'accent est mis tout particulièrement sur un modèle du changement des représentations basé sur la réussite par opposition à un modèle du changement du comportement basé sur l'échec. Le matériel consiste en une comparaison des données meta-linguistiques et de réparation chez des enfants. Nous essayons de montrer que la perceptivité meta-linguistique ne joue qu'un rôle négligeable ou nul dans le *macro-développement* du *langage*, un rôle mineur dans le traitement linguistique *en temps réel*, mais que les représentations verbales jouent un rôle essentiel dans le macro-développement global. Les conséquences du modèle sont rapidement examinées en ce qui concerne le statut représentationnel du langage d'enfants avec un QI faible et de locuteurs adultes d'une langue étrangère. Le fait que certains aspects seulement du langage soient accessibles à la conscience est aussi pris en considération. Ceci conduit à des spéculations sur la plausibilité qu'il y aurait à considérer la modularité comme un *produit* de certains aspects du développement, et non exclusivement comme une caractéristique innée.