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# PSYCHOLOGICAL & LINGUISTIC APPROACHES TO LANGUAGE ACQUISITION

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*Language acquisition research experienced a boom following the Chomskyian revolution. The focus of attention centred primarily on the English child's acquisition of syntax. In the seventies, the range of problem areas in language acquisition began to diversify and alternative perspectives (non-nativist) on how the child acquires language began to emerge. It is argued that socio-cognitive approaches to language acquisition, though providing an important prerequisite for the acquisition of linguistic structure, cannot themselves account for the acquisition of the complex mapping relation between grammar and meaning that is required for full-blooded linguistic communication. Recent trends in language acquisition research including Learnability theory, Individual differences and Cross-linguistic approaches are reviewed. The article concludes with speculation about the future role of non-nativist approaches in language acquisition research. Although much current detailed work would seem to point to the existence of a Language Acquisition Device that is specifically tuned to the processing of linguistic information, it is premature to conclude that a more general cognitive learning mechanism that is able to account for both universal and particular properties of linguistic development, cannot provide a more parsimonious explanation of acquisition.*

## 1. Introduction

Speculation concerning young children's ability to acquire their mother tongue has for centuries attracted the attention of scholars from a wide variety of disciplines. Darwin commented on the language development of his grandchild and Augustine [1949] introspected on his own experience of acquiring a first language as a child. Not only does the transformation of the speechless 6 month old infant into a grammatically sophisticated 30 month old demand an explanation but it also prompts heated discussion as to the nature of this apparently species-specific skill. To what extent is the unfolding of linguistic knowledge guided by a genetically determined maturational process? Is this maturational process specifically linguistic in nature or are more general cognitive learning mechanisms involved? If the latter, what general learning mechanism differentiates »homo sapiens« from the other primates? Attempts to identify biological determinants of language acquisition in »homo sapiens« have rested primarily on studies of critical periods for acquisition (Lenneberg [1967]) and investigations of

aphasia where explicit language deficits are related to specific brain injury (Geshwind [1972]). Investigation of the peripheral mechanisms involved in the processes of language comprehension and production i.e. the functioning of the ear and the vocal apparatus, demonstrate how the forms of language fit perceptual and motor skills which indisputably are governed by important genetic factors (Denes & Pinson [1973]; Liberman et al. [1967]). It has even been possible to demonstrate that some of these peripheral mechanisms are shared with other species (Eimas [1975]). However, none of these investigations have been able to take a decisive stand as to whether the acquisition of linguistic structure in »homo sapiens« is the result of inherited skills that are specifically linguistic in nature or of a more general cognitive character i.e. a learning mechanism that can be applied to the acquisition of knowledge both linguistic and non-linguistic.

During the past three decades, psychologists and linguists have expended considerable effort in attempts to delineate the nature of the task facing young children acquiring their native tongue and uncover the means by which young children solve the problem of constructing anew their own communicative systems. A central assumption in this research endeavour is that knowledge of language can be best characterised as knowledge of a complex system of symbols and rules for manipulating those symbols. Language acquisition consists in uncovering the particular set of symbols and rules that apply to a given natural language. It is, furthermore, assumed that any adequate account of language acquisition must explain the productivity (or creativity) of language usage. Acquisition of a natural language is not just the mental storage of a set of sentence tokens heard by the child but the abstraction of regularities and structures that enable the child to go beyond the input to be able to create sentence tokens that, perhaps, have never been uttered previously.

The study of linguistic structure, as reflected in the study of the linguistic productions of »homo sapiens«, can be a source of hypotheses as to the nature of the mental representations that are an important prerequisite for the appropriate usage of language. Thus, a given linguistic theory can be interpreted as a blueprint for the representations that underlie the behaviour on which linguistic generalisations are made. Linguistic theory provides a delineation of the nature of the task facing the language learner, and just as the physicist may obtain insights into the nature of atomic structure by observing the behaviour of atomic particles in a cloud chamber, so might the linguist uncover the essence of human language by analysing the traces that words leave behind them. Notice that there is no necessary connection between the study of language behaviour in terms of the structures weaved by words and the view that language acquisition is a process that requires a specifically linguistic orientation. Linguistic structure can, in principle, just as well emerge from the operation of a general learning mechanism as from the operation of domain specific mechanisms. However,

many linguists (notably Chomsky [1980]) have argued that the nature of the regularities and structures which they have uncovered are so idiosyncratic and complex that it is highly unlikely that close parallels will be discovered in other cognitive domains. Furthermore, the search space of possible linguistic systems consistent with a finite set of input sentence tokens is so large (in principle, infinitely large) that any discovery procedure that will enable the child to select the correct structural description of the language that s/he hears must be constrained so as to enable the target language to be discovered in finite time. It is argued that the constraints on the discovery procedure are determined by a »universal grammar« instantiated in a genetically specified Language Acquisition Device (LAD). On this view then, the process of language acquisition is governed by learning mechanisms which are specifically oriented to the discovery of linguistic patterns in the input to the child.

Abstract characterisations of the structures found in the linguistic productions of individuals need only have an indirect relation to the processes that are responsible for generating such productions. Again, the analogy with the physicist studying atomic particles is helpful here: The behaviour of particles in a cloud chamber can lead to the observation of regularities that have little, if anything to do with the processes that lead to their generation. Psychologists concerned with language acquisition have been careful to distinguish between the descriptions attributed to children's linguistic productions and the mental processes which themselves lead to these productions and manifestations of linguistic structure and regularities. Although there is no necessary relation between the focus on mental process and a standpoint on the specificity of the learning mechanism involved in the acquisition of linguistic skills, there has been a tendency amongst psychologists to view linguistic structure as resulting from the operation of a more general mechanism. Thus, it is often argued that linguistic form emerges from the demands of a complex communicative task in which the constituent linguistic elements are structured in a fashion that fulfils the functional demands of the message. The fact that language is used to transfer ideas about actual and possible worlds between speaker and hearer, and that there are general practical constraints (e.g. that you can only say one word at a time or that you have to talk in a way that your listener can understand) is seen as a compelling argument for concluding that the task of acquiring linguistic structure is driven by more functionally as opposed to structurally ordered considerations.

Many psychologists and linguists would object to this characterisation of their discipline's approach to the problem of language acquisition. And, indeed, just as there is no necessary relation between a particular discipline and its theoretical perspective on the mechanisms of language acquisition, so are a variety of perspectives represented within the disciplines of psychology and linguistics themselves. However, this cha-

racterisation not only serves to outline the dominant perspectives within a given discipline's treatment of language acquisition but it also serves to introduce a second theme in research on child language acquisition. We observe that the issue as to whether acquisition is governed by general or specific mechanisms closely parallels the differentiation between structuralist and functionalist accounts of language acquisition, comprehension and production. Structuralist accounts often (though again not of necessity) emphasise the specific (arbitrary) nature of the domain being described (and thereby the need for specific mechanisms to support its manifestation). Functionalist accounts underline the relationship between the domain of interest and its functional contextualisation in other domains (including the external environment) and point to this relationship as a means by which more general learning mechanisms can be applied to the construction of a knowledge domain which is highly specific in content.

The aim of this essay is to outline how the disciplines of psychology and linguistics have contributed to our understanding of how the young child gains access to his/her linguistic community. More specifically, attention is focused on the nature of the mechanisms that support language acquisition. As we have already seen, this issue is closely related to one's conceptualisation of the nature of the task facing the young child about to acquire its native language. We proceed by first reviewing the attempts of a number of psychologists to account for linguistic skills by appealing to the socio-cognitive foundations of the communicative situation. I will argue that although this perspective provides necessary information concerning the factors that contribute to the process of language acquisition, it is inadequate to the task of providing an explanation of the mechanisms by which the demands of the communicative situation are conventionalised and encoded in linguistic form. Second, I will briefly outline two mainstream approaches to language acquisition research in the eighties. The first of these mainstream approaches is concerned with the so-called »Logical problem of language acquisition«. It is closely tied up with a number of apparent »paradoxes« facing the young child acquiring language. In particular, we will discuss »Baker's paradox« (Pinker [1989]) and the issue of negative evidence. The second mainstream approach of the eighties has been a concern with individual differences between children in the process and end result of language acquisition. We will discuss both the implications of differences between children learning the same language and cross-linguistic differences (and, of course, similarities) between children learning different languages. Finally, we will conclude with a discussion of the relationship between nativist and non-nativist approaches to language acquisition, their likely status in the nineties and more general speculation concerning the future of child language acquisition research in the coming decade.

## 2. Socio-Cognitive Approaches

Child language acquisition research in the sixties was dominated by the Chomskyian revolution in psychology and linguistics. A central pre-occupation with symbolic, rule-governed mental representations led acquisition researchers to conceive of the developmental stages of language in children in the same vein. The acquisition of language was seen as the acquisition of a symbol system, manipulable by a set of linguistic rules. Successive stages on the way to full adult mastery of the language was characterised by successive child grammars that provided the generative base for the child's productions and the ability to understand linguistic expressions. Different theories placed different demands on the manner in which the characterisation of the child's knowledge related to current theoretical characterisations of adult linguistic knowledge. For example, pivot-open grammar (Braine [1963]) seemed to have little relation to linguists' intuitions about adult grammars whilst Bloom [1970] provided a carefully designed description of child language in terms of the dominant linguistic approach to adult language at the time, namely transformational grammar. Linguists and psychologists working on language acquisition were primarily concerned with understanding the young child's mastery of syntax. In fact, there was a tendency to ignore much of early language that could not be attributed some kind of propositional structure. Attention focused on the so-called two-word stage and beyond. Two issues dominated this period in the history of child language acquisition research.

- Was it possible to characterise a young child's linguistic productions in terms of a set of rules?

- Given that children's linguistic systems are rule-based, to what extent do these systems resemble the linguistic systems of adults?

An implicit assumption of much of the work carried out during this period was that the child's linguistic system might provide a simplified and more tractable window on the adult linguistic system. For example, it was suggested by McNeill [1966] that the categories of pivot-open grammar might provide a generic foundation for adult grammatical categories and Bloom [1970] built into her grammatical descriptions, generative components that were essentially striped down versions of transformational grammar. The disciplinary perspective on child language research during this period was primarily linguistic. Bloom's argumentation for a rejection of pivot-open grammar accounts of two-word utterances illustrates the orientation. Bloom observed that her child Kathryn produced the utterance »Mommy sock« on two separate occasions during the same day (thus, presumably generated by the same linguistic system). However, the interpretations gi-

ven to »Mommy sock« were distinct on the two occasions. In one case, Kathryn uttered »Mommy sock« in a context that suggested a POSSESSOR-POSSESSED relation (That's mommy's sock). On the other occasion, Kathryn seemed to encode an AGENT-OBJECT relation (Mommy is putting my sock on). Bloom reasoned that since the primary role of grammar is to provide a mapping between form and meaning, we might assume that distinct meanings of »Mommy sock« might be attributed distinct linguistic forms. Since the two tokens of »Mommy sock« had identical surface forms, then the meaning differences between the two forms must be grounded in a difference in the underlying forms of the utterances or to use a popular term of the time, the two tokens of »Mommy sock« must have distinct deep structures. Pivot-open grammar was unable to deal with the ambiguity of the utterance »Mommy sock« because it had no linguistic apparatus for generating alternative structural descriptions of the same utterance. The pivot-open characterisation of the child's knowledge of language was too impoverished to capture the rich set of linguistic distinctions which children seemed to command even at the two-word stage.

English is a language which relies heavily on syntactic devices for encoding the grammatical relations in an utterance. Other languages rely on, for example, morphology for achieving the same results and may use word order for pragmatic purposes or stylistic effect. Thus, Turkish has a stable accusative inflexion for encoding the object of an utterance and the grammatical role of the accusatively inflected noun is unaffected by its position in the sentence. Italian uses a much wider range of word orders than English, typically to highlight distinct topic (theme) – comment structures rather than encode grammatical role. Given the heavy emphasis in English on syntax to encode grammatical role, it is not surprising that English-speaking researchers were primarily occupied with child's acquisition of syntactic form as a means to encode propositions. Furthermore, given Chomsky's view of syntax as a modularised linguistic system, encapsulated from and impenetrable by other aspects of the linguistic system (phonology, pragmatics and semantics) as well as other non-linguistic cognitive domains, syntax was attributed the status in child language research as a domain that could be investigated on an autonomous basis independently of considerations of meaning and function.

### *2.1 Cognitive Foundations*

This approach underwent some modification in language acquisition research in the late sixties when some researchers became discontent with the purely formal, syntactic descriptions of child language that ignored other essential aspects of the »language making capacity« (Slobin [1985]). It was felt that although syntax was clearly an important domain of investigation,

other issues like semantics and pragmatics deserved attention. At the same time, psychologists were coming to terms with Piaget's structuralist approach to cognitive development and, in particular, with his views on the relationship between language and cognition, in which (at least, during the early stages of development) language was attributed a secondary role. During the early seventies, both psychologists and linguists began to devote increasing attention to semantic development in young children. Instead of investigating the relationship between child and adult grammars, researchers asked questions concerning the relationship between child and adult meanings and the interpretation of erroneous usage of words by young children. Thus, Clark [1973] advanced the »Semantic Feature Hypothesis« in which word meanings were based on a set of perceptual primitives and over-extension of words (like saying 'cow' to refer to a horse) were due to an inappropriate or inadequately specified list of perceptual primitives to define the given word. Similarly, Nelson [1974] suggested that early word meanings were functionally based (the »Functional Core Hypothesis«) and that over-extensions could be explained in terms of the functional similarity of different objects. Common to these (and many other) theoretical approaches was the attempt to ground early linguistic productions in cognitive structure. A general perspective of the time was summarised by (Cromer [1974]) in what he dubbed the »Cognition hypothesis«.

> We are able to understand and productively to use particular linguistic structures only when our cognitive abilities enable us to do so.

It became clear that the task of explaining language acquisition had to be carried out at several levels. Since cognitive structures themselves were undergoing change in the young child, and because linguistic structure requires referential grounding in order for it to have meaning, it was felt that an understanding of the development of cognitive structure might provide important clues to developmental change at the linguistic level. We may distinguish two versions of the »Cognition hypothesis«, the strong and the weak. The strong version of the hypothesis maintains that cognitive structure provides a necessary and sufficient foundation for the emergence of linguistic structure. Thus, linguistic meanings are determined by the cognitive primitives (functional or perceptual) on which they are based. This view is sometimes called Cognitive Determinism (Schlesinger [1977]). It is diametrically opposed to a relativistic view of language structure such as Whorf's linguistic determinism (Whorf [1956]) and provides a theoretical foundation for explaining the existence of universals in the developmental process. Since cognitive structure determines linguistic structure, the universal processes of cognitive development (such as those proposed by Piaget [1953]) are reflected in universal processes of linguistic development. On this view, the investigation of linguistic structure is reduced to

an investigation of emergent cognitive structure. This »cognitivist« perspective fitted in well with findings not only from Genevan developmental psychology but with trends in cognitive anthropology (Berlin & Kay [1969]) and cognitive psychology (Rosch [1973]) that attempted to relate properties of conceptual structure to properties of the physiological system and the 'real world'.

The weak version of the »Cognition hypothesis« maintains that the emergence of cognitive structure is a necessary though not sufficient condition for the emergence of linguistic structure. Macnamara [1972] has articulated this view most clearly. Consider a child learning the syntax of simple active sentences in Danish. Let us suppose that the child hears the following two utterances:

| | | |
|---|---|---|
| (1) | *Drengen slår pigen.* | 'The boy hits the girl.' |
| (2) | *Pigen slår drengen.* | 'The girl hits the boy.' |

On what grounds can the child conclude that the two utterances have different meanings by virtue of the placement of the noun phrases in the utterances. Macnamara argues that the only means by which the child could capture this syntactic fact about a language is to observe that the utterances are used to describe different events and that there is a consistent relation between the position of the noun phrase, say, in the utterance and the referent's role in the event. However, in order to reach these conclusions the child must be able to make sense of the event that the utterance describes and ascribe roles to the participants (who did what to whom). According to Piaget [1953], the ability to ascribe event roles in this fashion is itself the result of a developmental process. Hence, we cannot expect a child to decipher linguisitic structures involving role attribution before s/he has mastered the cognitive foundations for understanding event structure. Macnamara [1972] aptly summarises this relation between linguistic and cognitive development as follows:

> Meaning is used as clue to language, rather than language as a clue to meaning.

Note that on this interpretation of the »Cognition hypothesis«, cognitive structure is a necessary condition for the emergence of linguistic structure but not a sufficient condition. The child still has to work out the covariance relations between a referent's role in an event and the grammatical encoding of the role in an utterance.

The shift in perspective towards identifying the cognitive determinants of linguistic structure carried with it the possibility of re-conceptualising the nature of the task facing the child learning his/her native tongue. For example, given that linguistic skills are founded in cognitive structure, to

what extent does it make sense to argue that syntax is an encapsulated linguistic domain, inpenetrable by other cognitive domains? The linguistic descriptions of transformational grammar and other generative theories were considered to lack a foundation in the mental processes that support comprehension, production and acquisition (Fodor, Bever & Garret [1974]). Alternative formulations of the structures underlying early combinatorial language began to emerge (Edwards [1973]). It was suggested that early combinations could be explained in terms of semantic roles or frames rather than purely formal, syntactic categories. Hence, combinations that expressed semantic relations like »agent-object« or »possessor-possessed« were interpreted as resulting from their cognitive saliency for the child rather than the result of the operation of a formal syntactic system.

### *2.2 Social Foundations*

In addition to these decidedly cognitivist attempts to provide the young child's emerging linguistic system with a referential and semantic grounding, concerted efforts were also made to relate linguistic development to the child's entrance into the social community. Bates, Camaioni & Volterra [1975] demonstrated how the child's cognitive development supported the emergence of various communicative skills and hence provided a platform for the emergence of linguistic form. For example, it was argued that the mastery of tool use in young children (characteristic of Piaget's sensorimotor stage V) was exploited by the young child in eliciting the cooperation of adults to achieve various goals, such as obtaining goods and services or simply eliciting attention. By anchoring linguistic expressions in socio-cognitive frames, an important step towards a functionalist approach to language acquisition was made.

Bruner [1975] provided a radical alternative to our understanding of the emergence of linguistic skills. Bruner was concerned to emphasise the continuity of the developmental process by drawing parallels between the functional role of linguistic expressions and some characteristics of »pre-linguistic« behaviours in the infant. For example, Bruner noted that young infants and their parents often engage in ritualised play in which routinised interactions between parent and child are repeated many times in successsion. Bruner provides a detailed description of the game »Peek-a-boo« as realised in play between one child and his mother. Bruner successfully demonstrates how even such apparently simply games have an intricate internal structure in which constituent parts can be moved around by parent or child, deleted or transformed. He further shows how the parent provides a »scaffolding« on which the child can elaborate his relatively incompetent performances. As the child becomes increasingly skilful, the parent gradually removes the scaffolding. Thus, the child early in develop-

ment may not take on all the different roles typical of such ritualised games. In such cases, the parent plays out the role for the child much as the master tradesman plays out various roles for his apprentice. As the child becomes more skilful in the different roles, the parent retreats more and more into the background until the child might even perform the complete ritual for himself.

In a somewhat provocative fashion, Bruner [1983] depicts the internal organisation of ritualised play as a hierarchical tree-structure, a form of representation often used by linguists to portray the syntactic relations between the constituents of an utterance. It is unclear whether Bruner supposes that these tree diagrams for describing the hierarchical structure of play rituals have any causal relationship to the constituent structure of sentences. However, these descriptions do reveal that the linguistic communications of parents towards their infants and the early verbal gestures of the infants are often contextualised in tightly defined interactive structures. Consistent grounding of linguistic form in this way can only contribute to the child's opportunity to discover the sound patterns of the ambient linguistic community. Furthermore, the context of this grounding i.e. social interaction, provides a means by which cultural determinants can impinge upon the development of both linguistic and cognitive skills. Indeed, one might extend this line of argument to propose a form of »social determinism« in which linguistic forms are molded by the characteristics of the social interactional structures in which they are grounded.

### *2.3 The Syntactician's Response*

Arguments for the cognitive and social foundations of linguistic structure convinced many child language researchers that there was little need to postulate an innate language acquisition device (LAD) to account for the speed and success with which young children acquire their native tongue. Many of the skills that are acquired during the pre-linguistic phase of development are preparing the child for the task of mastering linguistic structure. A good deal of research in the seventies contributed substantially to our understanding of the development of semantic and pragmatic skills in young children and their realisation in linguistic expression. We began to be able to account for why children tend to express some meanings rather than others in their vocabularies and why the functions of early linguistic expressions seemed to be limited in scope. For the syntactician interested in child language, however, the socio-cognitive approach prevalent during this period carried less sway. The seeds of this discontent can be traced back to the formulation put forward by Macnamara as to how the young child might go about resolving the problem of how word order relates to meaning (see page 72). Macnamara showed how knowledge of the meaning of an ut-

terance was a necessary prerequisite for deciphering the syntactic code of a simple active sentence. However, it was not claimed that knowledge of the mean-ing provided direct access to the grammatical structure of the utterance that encoded the event. The child still has to do a great deal of linguistic work to discover the precise means by which his/her native language assigns roles to syntactic devices. Indeed, this is precisely the problem that a developmentalist interested in syntax is trying to resolve. A cross-linguistic example might help to clarify this point. As noted earlier (see page 70), Turkish encodes accusative object by suffixation. In contrast, English and Danish make use of word order to indicate accusative role. We presume that there is nothing in the event structure itself (a boy hitting a girl, say) which indicates to the child whether s/he is learning Danish or Turkish. The child has to pay attention to the linguistic input in order to discover which devices are used to encode grammatical roles. Macnamara's point is that contrasts in meaning alert the child to contrasts in linguistic structure. However, contrasts in meaning do not, in and of themselves, inform the child of the relevant dimensions of syntactic differentiation. The question then arises as to how the child, given access to relevant meaning contrasts, goes about the task of deciphering the mapping relation between linguistic form and meaning. In the next section, we consider the arguments as to why many developmental syntacticians still believe that it is necessary to postulate a substantive innate component to account for language acquisition.

## 3. Recent Trends

Although the seventies witnessed an enormous expansion both in the number of researchers involved in child language and in the range of topics investigated, many of the problems judged to be of central importance for language acquisition in the sixties remained unresolved. The central concern of this essay is how the young child comes to master the morpho-syntactic patterns of his/her language. The socio-cognitive perspective showed how the child might ground formal syntactic knowledge in semantic representations and referential relationships. It does not show how the syntactic relations themselves are acquired. In this section, we consider two types of argument that bear on the issue of the nature of the mechanism involved in the acquisition of syntax. First, we consider a development in the late seventies which took on a dominating perspective in the eighties, namely »Learnability theory«. This perspective attempts to characterise the essence of the learning task facing the child in terms of the learnability of various language types. Second, we take up the issue of profile differences in language acquisition and consider various propo-

sals that differences in acquisition both within and across languages provide insights into the acquisition process.

### *3.1 Learnability Theory*

Consider a child exposed to a given linguistic environment, say Danish. From the classical cognitivist perspective, the child's task in acquiring a native language is to extract from the input data i.e., the language that s/he hears, a set of symbols and rules for manipulating those symbols, that will enable him/her to generate an (in principle) unlimited number of utterance strings that conform to the target grammar of the language. It is assumed that the child goes about this task in an »active« fashion by postulating a succession of hypotheses concerning the precise nature of the target grammar. Hypotheses are rejected when input utterances (utterances heard by the child) do not adhere to the grammatical structures generated by the current hypothesis or when output utterances (utterances produced by the child him/herself) are not accepted by the linguistic community as acceptable strings in the language. The first type of evidence i.e. demonstrations by the linguistic community of legal strings in the language, is called »Positive evidence«. The second type of evidence i.e. feedback from the linguistic community that strings produced by the child are illegal, is called »Negative evidence«. Let us suppose for the moment that the child's hypothesis generating mechanism postulates complete grammars for the target language[2]. Thus, the child is capable, in principle, of producing all the strings (possibly an infinite number) consistent with the postulated grammar. It is conceivable that the child hits upon the target grammar at his/her first shot. Learning will then have been »instantaneous«. However, given the enormity of the search space of possible grammars, the chances of hitting on the correct grammar first time are remote. Let us represent the complete set of sentence tokens generated by a grammar by a circle[3]. Furthermore, let us represent positive evidence by a '+' and negative evidence by a '−'. We can imagine four possible situations that relate the child's correct or incorrect productions to the productions of the linguistic community. First, the child may generate strings which in grammatical form do not overlap with the forms produced by the linguistic community. This situation is depicted in Figure 1(a).

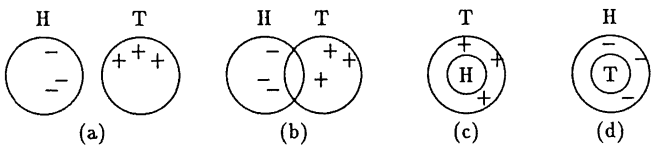


*Figure 1:* Relations between the child's hypothesised grammar (H) and the target grammar (T)

In just this case, all utterance tokens produced by the linguistic community will have the status of positive evidence that forces the child to abandon his/her hypothesised grammar. In the case of 1(b), there is an overlap between the set of sentences generated by the child's grammar and the target grammar. Hence, some sentence tokens will serve to confirm the child's own hypothesis whilst other sentence tokens from the linguisitic community will act as positive evidence that again forces the child to generate a new hypothesis. In 1(c), the hypothesised grammar is a subset of the target grammar. In this case, all utterance tokens produced by the child count as grammatical strings in the target grammar. However, the child's hypothesised grammar is not as powerful as the target grammar since it generates a narrower range of strings. In 1(c), the child's grammar is »under-extended«. Again, positive evidence from the linguistic community can remedy this situation. Finally, in 1(d), the target grammar is a subset of the hypothesised grammar. In this case, the child's grammar is »over-generalised«. The child requires negative evidence from the linguistic community in order to force him/her to abandon the overly general grammar. Notice that in cases 1(a)-(c), positive evidence is sufficient for the child to focus in on the target grammar. Only in the situation portrayed by 1(d) is negative evidence required to save the child from false hypotheses.

Let us now consider a concrete example, first discussed in this context by Baker [1979]. In Danish, as in English, verbs take arguments that may be either obligatory or optional. Thus, in the sentence:

(3) *Jens slår på væggen med en hammer.*
'Jens hits the wall with a hammer.'

'with a hammer' is optional, while in the sentence:

(4) *Jens satte koppen på bordet.*
'Jens put the cup on the table.'

'on the table' is obligatory. It has been argued (Bresnan [1982]; Pinker [1984]; Pinker [1989]) that the acquisition of verb argument structure constitutes one of the most important tasks confronting the child learning his/her native tongue[4]. However, it also constitutes a potential source of error. Consider the following 'dative alternations'.

(5) *Forfatteren fortalte en historie til drengene.*
'The author told a story to the boys.'

*Forfatteren fortalte drengene en historie.*
'The author told the boys a story.'

(6) *Moren gav en bog til pigen.*
'The mother gave a book to the girl.'

*Moren gav pigen en bog.*
'The mother gave the girl a book.'

The regularities observed in these sentence pairs suggest a generative rule for transforming the argument structure of the verbs *at fortælle* 'to tell' and *at give* 'to give' that might be formulated as follows:

(7) $NP_1$__$NP_2$ to-$NP_3$ → $NP_1$__$NP_3$ $NP_2$

Given sufficient exposure to dative alternations of the type illustrated in (5) and (6), we might expect the young child learning Danish or English to hypothesise a rule of the kind illustrated in (7). The hypothesised rule would then enable the child to generalise the dative alternation to utterances containing *fortælle* and *give* but with different arguments, and to verbs which take similar prepositional arguments. In this manner, the child's language achieves creativity and productivity. However, now consider the following string pairs:

(8) *Maleren skænkede et billede til museet.*
'The painter donated a picture to the museum.'

**Maleren skænkede museet et billede.*
*'The painter donated the museum a picture.'

(9) *Jens berettede om et uheld til politiet.*
'Jens reported an accident to the police.'

**Jens berettede politiet om et uheld.*
*'Jens reported the police an accident.'

According to the generalisation formalised in (7), the dative alternations in (8) and (9) should be legal strings in the target language. However, as far as Danish and English are concerned, the strings without a preposition are illegal. Thus, if the child hypotheses a rule such as (7), which applies in many other situations, then s/he must learn to constrain the domain of application. Evidently, the only way the child can learn about the exceptions to the rule is to be provided with negative evidence from the linguistic community. The child can then, presumably, learn to constrain the domain of application of (7) in just the same way as s/he would restrict the domain of application of the past tense inflexion on regular verbs, so

as not to produce errors such as 'went-ed' or 'go-ed'. Negative evidence is thus seen to be an important part of the learning process.

It is at this point that the learning paradox (or Baker's paradox) becomes apparent. Most studies to date are equivocal about the extent to which negative evidence is available to the child in the language learning situation. And if negative evidence is unavailable, how is the child to retreat from situations, such as (7), in which the hypothesised grammar constitutes a super-set of the target grammar? In formal learnability theory (Gold [1967]), negative evidence is said to be available when the explicit marking of a string as ungrammatical is provided. Since Brown & Hanlon [1970], most researchers have agreed that parents rarely offer negative feedback of the kind 'Johnny, you didn't say that correctly'. Other researchers (Demetras, Post & Snow [1986]; Hirsh-Pasek, Treiman & Schneiderma [1984]) have argued that negative evidence is available to the child in a more indirect form e.g. that parents follow up ungrammatical strings by repeating, questioning or altering the child's utterance in some way. However, it is not clear from these studies just how consistently this feedback is provided to the child or how the child is to evaluate which aspect of his/her utterance was incorrect. In fact, Pinker [1989] argues that most of the questions that revolve around how the child goes about identifying negative evidence and applying it appropriately to constraining his/her grammar presuppose the kind of solution required to solve the learning paradox. If we assume, for the time being, that negative evidence is neither sufficiently stable nor focused for the child to use it as a means to constrain the hypothesised grammar, then two solutions would seem to offer themselves.

- Universal grammar, as instantiated in a Language Acquisition Device, precludes specific argument structures for particular types of verbs.

This solution would predict, for example, a universal constraint on dative alternation for certain verbs. This would explain why Danish and English share so many dative alternation constraints (see (3)–(6), (8) and (9)). However, this nativist position also predicts that children should never make any errors of the kind observed in (8) and (9). For once a rule like (7) was postulated there would be no retreating from it. This prediction is clearly incorrect. Consider the following utterances produced by a Danish child 'Anne' at the age of two years and seven months:

| | | | |
|---|---|---|---|
| (10) | Anne: | *Gider du lave mig?* | 'Would you make me?' |
| | Mother: | *Ja. Det vil jeg gerne.* | 'Yes. I will.' |
| | Anne: | *Tril mig den.* | 'Roll me it' |

In Danish, the verb *at trille* 'to roll' does not permit dative alternation. The correct form is *Tril den til mig* 'Roll it to me.' The expression *Gider du lave mig* 'Would you make me' might also involve an illegal dative alternation. However, this case is ambiguous since the direct object *den* is omitted. Evidently, universal grammar is not powerful enough to prevent this Danish child from over-extending (7)[5]. It should also be noted from (10) that the mother provides no indication to Anne that her utterance does not confirm to adult target norms. In fact, this mother hardly ever provides feedback to Anne that could be interpreted as clear negative evidence.

A second solution offered by Pinker [1989] refers to a set of semantic and morphological criteria:

- The acquisition of verb argument structure and thereby the constraints on, say, dative alternation demands that the child pay close attention to the semantic structure of the labels used by adults.

On this view, the errors produced by children are not a result of the overgeneralisation of a rule but an inadequate specification (in relation to the adult specification) of the meaning of the verb. The general form of verb argument structure is the same for adults and children (as specified in universal grammar). However, the manifestation of verb argument structure is influenced by semantic and morphological considerations. As the child learns more about the meaning of a verb, s/he comes to honour the constraints of the target language. Thus, in (10), Anne does not contravene the rules of Danish. She simply does not know enough about the meaning of *trille* to restrict its argument structure appropriately.

The solution to Baker's paradox offered here falls fairly and squarely within the nativist camp. For Pinker's argument to work, the child must come equipped with some form of universal grammar that enables him/her to delimit the range of rules or parameters that characterise natural languages and get the child started on the acquisition process. Furthermore, it must be shown how the syntactic component of language interacts with semantic and morphological considerations. Pinker [1989] has made an admirable attempt to describe, in detail, the fashion in which a child might go about unravelling this extraordinary complex problem. We see in Pinker's solution an integration of the socio-cognitive approach to language acquisition prevalent in the seventies and the nativist approach prevalent in the sixties – both formal syntax and semantic structure (and its underlying conceptual structures) are required for the task of language acquisition. In the final section of this article, we will consider the outlines of an alternative solution to Baker's paradox which does not warrant the postulation of an innate, specifically linguistic, learning mechanism.

### *3.2 Differences in Language Acquisition*

Most studies of early language acquisition involve small samples of children. For example, Brown [1973] studied three American English speaking children over a period of several years, Lange & Larsson [1977] report a longitudinal study of three Swedish children and Plunkett [1986] provides a preliminary analysis of the cognitive and linguistic development of two Danish children. There are two major factors that contribute to the focus on small sample studies.

1. Data collection and analysis is an extremely time consuming process. For example, it often takes 30 hrs. to draft a first transcription of 1 hr. dialogue. Consequently, detailed longitudinal databases involving many children are non-existent[6].

2. A common assumption amongst child language researchers, particularly during the sixties and seventies, is that the acquisition process is universal i.e. children go through similar stages of development. Thus, all children pass through a one-word stage to a two-word stage and early combinatorial speech expresses a similar set of semantic relations across a wide variety of cultures and social settings. The order of acquisition of inflexional morphemes is also thought to be consistent both within the learners of a given language and across languages. Differences in the developmental profile of children are attributed to extraneous issues relating to »performance« in much the same way that adult speech errors and slips of the tongue are attributed to a non-competence component which is unessential to an understanding of the linguistic skills themselves. Since acquisition is similar across children it is only necessary to study a small number of children to gain insights into the acquisition process which are representative of all children.

Taken together, these two factors led to the formulation of theoretical accounts of language acquisition based on data taken from a very small sample of the population. As we have already seen, these accounts tended to emphasise the universal aspects of language development. However, a number of researchers and in particular Nelson [1973], began to collect longitudinal data samples from a larger number of children and submit these data to a relatively thorough analysis. Other researchers, notably Slobin [1973], began to conduct cross-linguisitic investigations of language acquisition to determine the validity of the universalist position. The profiles of development in children learning language in a wider variety of cultures began to become accessible to the child language community.

### *3.2.1 Individual Differences*

In a study of 18 English speaking children, Nelson [1973] observed differences in the developmental profiles of the children she followed. In itself, this observation was of no great import. However, instead of concluding that the individual differences between the children were due to performance factors and therefore unimportant for characterising the emergence of linguistic knowledge, Nelson took the results seriously and attempted to trace a pattern in the differences observed. One of her main findings was that children differ considerably in the degree to which they use concrete nouns and pronouns in their early vocabulary. In fact, she was able to distinguish two groups of children, one of which rarely used concrete nouns but frequently used pronouns whilst another group rarely used pronouns but frequently used concrete nouns. Nelson suggested that these differences might be related to differences in the »strategies« that children apply in the language learning situation. Thus, some children are somewhat »analytic« in their language learning strategy and parse input sentences so as to extract words that can be used to perform precise referential acts. Other children are more »holistic« in their approach to language and use words that have more general reference, such as pronouns. This idea lay dormant for a number of years but was taken up again by Nelson [1981] in a more theoretically grounded account of individual differences in language acquisition and their implications for understanding the mechanisms of language acquisition. Later, other empirical work on individual differences began to emerge. For example, Bates, Bretherton & Snyder [1988] conducted a large scale quasi-longitudinal study that used multi-factor analysis to uncover the most significant dimensions of linguistic and cognitive variation across the children. Their results revealed that various cognitive and linguistic measures (e.g. size of productive vocabulary, percentage of conrete nouns, comprehension skills, mean length of utterance, etc.) clustered around 4 main category types.

Like Nelson, Bates, Bretherton & Snyder [1988] concluded that the observed differences might result from the application of different strategies to the language learning task. It must be emphasised, however, that the same child might use different strategies at different points in development or different strategies to solve different linguistic problems. For example, Bates [personal communication] describes how her daughter Julia possessed all the characteristics of a so-called »referential« (or analytic) language user (large concrete noun vocabulary, early emergence of combinatorial speech) when she was acquiring English. However, on being presented with the task of acquiring Italian (the family moved to Rome), Julia immediately switched to being a »holistic« child (though her English still retained its referential bias). Similarly, Hayashi [1990] in a study of Danish-Japanese

bilingualism observes differences in strategy preference according to the language being used.

These observations raise the question as to the source of the strategy differences themselves and the nature of the mechanisms that support the different strategies. For example, are language learning strategies endogenous to the child or do they emerge from the child's interaction with his/her environment? And are the distinct strategies exploited by the child grounded in distinct socio-cognitive-linguistic mechansisms or are the different learning strategies a manifestation of different modes of operation of a single (or small number) underlying mechanism? One of the first attempts to address these issues was initiated by Peters [1983]. Peters main goal was to identify a set of criteria that would enable a child language researcher to uncover the basic units of language acquisition in any given child. Consider the Danish utterance *Hvad er det?* 'What is that?'. As far as the adult norm is concerned, the utterance contains three constituent morphemes: *Hvad, er* and *det*. However, it is unclear whether a Danish child using this expression has knowledge of the expression's compositional structure. For example, the child may simply be imitating a sequence of sounds frequently used by a parent. In this case, the process of generating an expression on the basis of set of rules for combining words would not seem to apply. Rather the utterance may have been learnt by rote without any attention to its internal structure. It would, therefore, seem inappropriate to attribute to the child the linguistic knowledge usually associated with the ability to produce such expressions. Peters proposed that we call such utterances »formulaic« expressions[7] and claimed that much of what is thought to be combinatorial speech in early language is formulaic.

This proposal is at odds with the traditional approach in linguistic analysis to evaluate the productivity and status of individual elements in an utterance in terms of their distributional properties. Thus, if an item occurs commonly in a range of different expressions, it is typically attributed a productive status. However, an item can, in principle, occur in a range of formulaic expressions without ever being productive. Furthermore, the formulaic expressions used by individuals may differ and hence be exceedingly difficult to identify. Individuals may also differ in the extent to which they make use of formulaic expressions in their linguistic productions. From the perspective of evaluating early language productions, formulaic expressions are especially problematic. If we wish to establish a profile of a child's language development, standard procedures include establishing measures of the child's active and passive vocabularies and calculating the average length of his/her utterances in words or morphemes. However, if the child's productions contain a large number of formulaic expressions, how are we to assess whether the child really does know a particular word, say *er* in the expression *Hvad er det*, or whether the child has actively constructed the utterance him/herself from a mental lexicon?

To illustrate the problem, consider the profile of development in the Mean Length of Utterance (MLU) of two Danish children Anne and Jens during their second year shown in Figure 2[8]. Mean length of utterance is calculated by counting the average number of words (or more accurately morphemes) in the child's utterances at any given age. Thus, if all utterances consist of only one word then the child's MLU will be 1.0. It assumed that the problem of identifying words in an utterance is unproblematic. MLU is typically used as measure of the child's level of syntactic ability during early language development. MLU has also been observed to correlate quite closely with the mastery of other aspects of language development e.g. the emergence of inflexional morphology and auxiliary verb usage (Brown [1973]). For many children (Miller & Chapman [1981]), MLU stays at a low level (close to 1.0) for the first half of the second year and thereafter increases gradually to an adult level[9].

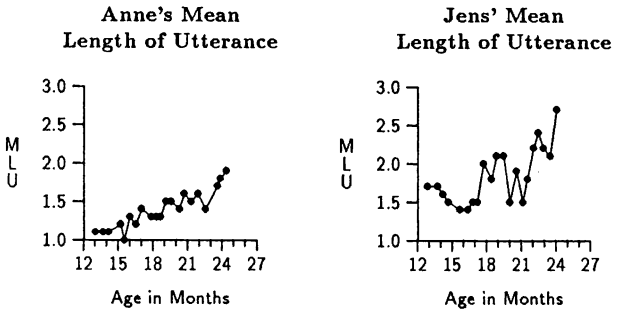


*Figure 2:* Anne and Jens' MLU during their second year

Figure 2 indicates that the Danish girl Anne has a fairly traditional MLU developmental profile. However, Jens' MLU is quite unusual. Not only is Jens' MLU at a very high level for his age throughout the period of study but he passes through a period of consecutive decreases in MLU during the first half of his second year. Plunkett [1986] speculates that Jens' generally high level of MLU might be attributed to a high level of usage of formulaic expressions during this period and that the U-shaped developmental phenomenon between 14 and 18 months is a result of Jens starting to use a more analytically-oriented strategy in the language learning situation. In terms of Peters [1983] account of the units of language acquisition, Jens is using large units as his productive base whilst Anne is using smaller word-like units. This speculation is supported by the finding (Plunkett & Klausen [1987]) that Jens tends to use fewer concrete nouns than Anne but a greater number of pronouns than Anne and that the regression in MLU for Jens observed around 16 months is accompanied by a substantial increase in the proportion of concrete nouns in his vocabulary.

Although the evidence presented is consistent with other researcher's categorisation of children as analytic or holistic language users, it is not

at all clear whether Jens' high MLU is due to a frequent use of formulaic expressions or whether his language is indeed precious (by normal standards). We require, like Peters [1983], some way of evaluating individual utterances for their formulaic/productive status. Peters [1983] observes that formulaic expressions are often produced by the child in a fluent fashion, that they have the intonational characteristics of adult sentences and are often badly articulated. In a follow up study, the results of which are presented here in summary form for the first time, we have re-analysed Annes' and Jens' utterances according to a set of articulatory/fluency criteria. In brief, if an utterance is badly/imprecisely articulated it is treated as a formulaic expression while a clearly/precisely articulated expression is treated as productive i.e. the component words of the utterance are given a productive status. An exposition of the theoretical foundations of this methodology is provided in Plunkett [1990]. The effects of this treatment on Anne's and Jens' MLU profile are shown in Figure 3.

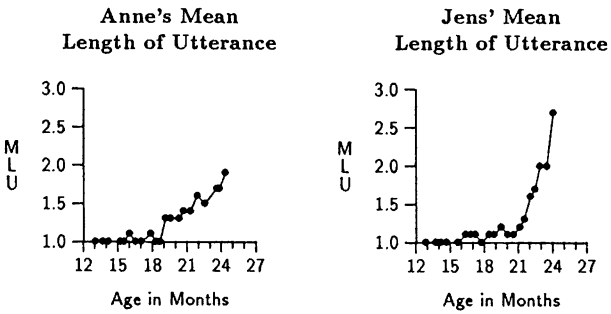


*Figure 3:* Anne and Jens' MLU using articulatory criteria

The re-analysis of the data effects the developmental profiles of MLU for both children, though most noticably for Jens. In particular, the high MLU for Jens during the first half of his second year is reduced to levels that resemble those of Anne and many other children reported in the literature. Although this is not conclusive evidence that Jens' early language usage is dominated by formulaic expressions, it suggests that the application of articulatory/fluency criteria may be a fruitful methodology for identifying formulaic speech. The U-shaped curve observed for Jens in Figure 2 is closely paralleled by a similar change in the frequency of usage of formulaic speech as identified by these criteria. We may then ask the question as to why such a difference exists between the two children. Although the data analysis is not yet complete, it is possible to suggest that environmental factors may be playing an important role. If we apply the same kind of methodology for identifying the formulaic status of an expression to the children's mothers, we observe that Anne's mother is articulate and referential in her language whilst Jens' mother uses more formulaic, fluent speech.

From the child's point of view, it is likely that fluent speech is more difficult to parse than articulate speech. It is almost certainly the case that articulate speech will provide better opportunities for identifying concrete nouns in the input string. Of course, a similar result would be forthcoming if the child had hearing problems (maybe an ear infection over a longer period) since input would also be more difficult to parse. We have no evidence that Jens was hard of hearing during the period of the investigation reported. Nevertheless, the environmental account of these results must be treated with some caution. It is unlikely parents talk to their children in identical ways – even within the same family. And siblings do differ considerably in their language habits. Validation of environmental factors as underlying differences in language acquisition must await larger scale, detailed investigation of children in interaction with their parents. These investigations are underway.

We may conclude then that individual differences between children may reflect alternative paths of language acquisition. Thus, some children may be more oriented to formulaic speech whilst others concentrate on single words[10]. It is not clear to what extent these different paths reflect the use of different mechanisms in the acquisition process, nor whether they have any consequences for the end state of the learning process (though see Wong-Fillmore [1979] for a discussion of individual differences between adults using the »same« language). The finding by many researchers that an orientation towards formulaic language usage goes hand in hand with a more expressive, social orientation suggests that there is a close link between the emergence of linguistic structure and its socio-cognitive context of acquisition. In any case, an acceptance of the importance of individual differences in the acquisition process can be interpreted as a questioning of the extent to which universal processes can account for the complexities of language acquisition.

### *3.2.2 Cross-Linguistic Approaches to Language Acquisition*

Slobin [1971] reports a study by Mikês & Vlahovič [1966] on the language acquisition of bilingual twins acquiring Serbo-Croatian and Hungarian in northern Yugoslavia. Mikês & Vlahovič [1966] observed that the encoding of spatial information in Hungarian was mastered by the twins before the age of two years whilst the encoding of spatial information in Serbo-Croatian was not acquired until much later. In terms of the strong version of the »Cognition hypothesis« (see section 2.1, page 70), this result is odd. The mastery of the linguistic encoding of spatial location in Hungarian suggests that the twins had mastered the necessary conceptual spatial understanding of, say, containment to ground the linguistic form in a meaningful representation. Why then did the twins fail to exploit this con-

ceptual understanding in the encoding of spatial location in Serbo-Croatian? Slobin [1971] argues that the complexity of the linguistic forms themselves are a determining factor in the developmental process. For example, Hungarian does not make use of locative prepositions to encode a containment relation but relies exclusively on inflexional suffixes. In contrast, Serbo-Croatian requires that both a locative preposition and a locative suffix are present in the linguistic encoding of containment. An example is provided in Table 1.

| Hungarian | | Serbo-Croatian | |
|---|---|---|---|
| *hájo* | *hájo-ban* | *kuç-a* | *u kuç-i* |
| boat | boat-in | house/hut | in house-LOCSUF |

*Table 1:* Locative expressions in Hungarian and Serbo-Croatian

Even though the use of locative prepositions is highly frequent in Serbo-Croatian, the complexity of the form required to encode this semantic category hinders the children in exploiting their conceptual understanding.

This small case study serves to underscore the importance of cross-linguistic comparisons for our understanding of the acquisition process. In this case, it enables us to evaluate the role that linguistic complexity plays in the acquisition process. However, cross-linguistic analysis can also serve to question some of the universalist assumptions that arise from focusing on a single language. For example, it was assumed that the preferred device for encoding the grammatical role of a noun in a sentence is word order. Thus, children learning a language that does not make use of word order to encode grammatical role are inclined to entertain hypotheses about the importance of word order in the input language before they explore the possibility that other linguistic devices may be performing this task (Bowerman [1973]). This assumption is a well formulated, testable hypothesis concerning universal aspects of language acquisition. However, the assumption is clearly a result of focusing on the acquisition of language in English-speaking children where word order is of overwhelming importance.

Slobin & Bever [1982] report a cross-linguistic study of comprehension skills in children learning English, Italian, Serbo-Croatian and Turkish. Slobin & Bever's methodolody consists in requesting young children to interpret various utterances by 'acting out' the events described in the utterance. The utterances can be either well-formed or ungrammatical strings in the child's own language. On the basis of the children's interpretations of the utterances, Slobin & Bever could evaluate the grammatical devices which seemed to play an important role in the interpretational process. For example, if an utterance required that the child pay attention to the order of words in an utterance to interpret it 'correctly' (e.g. as in 'The horse kicked the cow.') the child's tendency to respond to these cues could be evaluated. Furthermore, Slobin & Bever were able to evaluate develop-

mental trends in the manner in which children respond to various linguistic cues, irrespective of whether or not those cues are salient in the adult target language. In Turkish, word order is of little importance in encoding the grammatical role of nouns in a sentence. For example, Turkish uses an inflexional suffix to encode the role of accusative object (see page 70). If the hypothesis concerning the saliency in early development of word order for encoding grammatical role is correct, then one would expect the Turkish child to ignore the grammatical means for encoding accusative objects that s/he hears in the linguistic community and spontaneously prefer word order as a device for interpreting utterances. Slobin & Bever [1982] note that Turkish children do not use word order as a cue for assigning utterance constituents to the role of accusative object but from a very early age (at least, as early as two years) exploit the highly reliable cue of an inflexional suffix for assignment to grammatical role.

So far, we have observed how cross-linguistic analysis can provide insights into the role that linguistic form itself plays in the developmental process and how comparison of developmental profiles across languages can verify and falsify universalist hypotheses concerning the nature of language acquisition. However, the cross-linguistic approach (Slobin [1985]) can also contribute to our understanding of semantic and conceptual development in the child. In the acquisition of English, children typically start to use the past tense forms of verbs during their third year (de Villiers & de Villiers [1985]). However, it is unclear whether children use these forms to encode a durative event in the past or a completed event in the past. In the latter case, as noted by Bloom, Lifter & Hafitz [1980], it would be more appropriate to interpret the past tense forms as past participles encoding resultative aspect. This interpretation is supported by the fact that in English, simple past tense forms and past participles are often indistinguishable. For example, the simple past tense form 'talked' and past participle in 'has talked' are identical. In English then, it is difficult to decide on the referential basis of the simple past tense forms. Researchers have disagreed as to the appropriate conclusion. On the one hand, it is generally agreed that the notion of a durative event in the past is conceptually more complex the notion of a completed event in the past. Thus, the linguistic encoding of resultative aspect should be developmentally prior to that of the durative past. On the other hand, the past participle in English normally takes an auxiliary verb. The auxiliary verb is missing in the first past tense form productions observed in English children. Hence, from a linguisitic point of view, the past participle status of these forms are brought into question.

In contrast, if we look at other languages e.g. Danish, German, Norwegian and Swedish, the simple past tense form (or Preterite as it is often called) and past participle are quite distinct. For example, in Danish *snakkede* 'talked' and *snakket* 'talked' encode simple past tense and past parti-

ciple, respectively. If we observe the mastery of these different forms of the verb by children learning Mainland Scandinavian languages (Plunkett & Strömqvist [1990]) and German (Mills [1985]), we find that the simple past tense forms are acquired much later (often towards the end of the third year) than past participle forms which are usually mastered by the beginning of the child's third year. Furthermore, the past participle forms are typically produced without an auxiliary verb (which is otherwise prescribed by the adult target norm) and are used to encode events that are completed i.e. resultative aspect. If we assume that the conceptual developments underlying the use of tense and aspect are relatively similar for English children, German children and Mainland Scandinavian children we may intrepret these results as indicating that resultative aspect is indeed developmentally prior both conceptually and linguistically to reference to a durative past and that the most parsimonious interpretation of the past tense forms first used by English children is that they are, in fact, past participles used to encode resultative aspect.

A cross-linguistic approach to the study of language acquisition can thus offer a rich source of evidence for evaluating hypotheses concerning the universal and specific characteristics of the developmental profiles of children acquiring their native tongue. In particular, cross-linguistic analysis enables us to see how the complexity of linguistic forms influence developmental profiles, and how the study of languages which explicitly encode conceptual distinctions at the linguistic level can illuminate the understanding of the conceptual and linguistic development of children learning languages where similar conceptual distinctions are not explicitly encoded.

## 4. Mechanisms of Language Acquisition

Vygotsky [1962] argues for the multi-functionality of linguistic expression and traces the foundations of verbal thought back to two independent roots – pre-intellectual speech and pre-linguistic thought (see Figure 4).

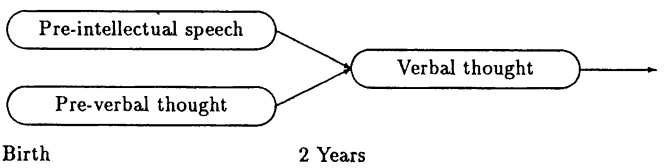


*Figure 4:* Pre-verbal thought and pre-intellectual speech in the development of verbal thought

Although the idea that the two developmental pathways remain completely independent of each other for such a long period is probably an over-simplification of their interaction, Vygotsky's picture of language

(or rather verbal thought) as an emergent property of the intersection of different domains of development still holds important lessons for us today. Neither speech nor thought is viewed as being the primary motivator of change. Rather the properties of the speech signal and the structure of cognitive processes merge to support new forms of behaviour that could never be realised by cognitive or verbal means alone. It is precisely at the point of intersection of pre-intellectual speech and pre-verbal thought that a young child's vocabulary experiences an explosive growth, that children start to produce productive combinatorial speech and conceptual structures take on a systematic organisation.

Much of the argumentation in this essay has been concerned with establishing a set of necessary and sufficient conditions for identifying the mastery of linguistic (and especially syntactic) structure. This goal is far from having been realised. However, we are nevertheless in a position to draw some initial conclusions about the acquisition process. First, it is recognised that the child must receive exposure to a linguistic system if s/he is to learn that system. Second, for the meaningful use of language to emerge, the child must have access to conceptual representations that ground the linguistic forms. In the absence of such grounding, speech – to borrow Vygotsky's expression – remains 'pre-intellectual'. Thirdly, it is unlikely that the machinery for achieving conceptual grounding can operate successfully in the absence of a rich social context. In summary, the acquisition of language must be viewed as an integrated socio-cognitive-linguistic process. However, we have also reviewed arguments that demonstrate that socio-cognitive knowledge in and of itself is insufficient to account for the detail of linguistic structure. How does an English child's knowledge of the social world (non-linguistic) inform him/her that auxiliary verbs are needed to construct syntactic negations or interrogatives? Further arguments demonstrate that the linguistic forms themselves carry insufficient information to determine their own organisation in the child's cognitive system (the so-called 'poverty of the stimulus argument'). A conclusion has been that the child must possess a powerful Language Acquisition Device that enables him/her to 'go beyond the information given' (Bruner [1957]) and construct a semantically grounded linguistic system.

Pinker [1989] has gone some way to establishing an interactionist view of acquisition in which semantic and conceptual structures modulate the action of a 'core grammar' and account for universal and specific processes in acquisition, as well as the errors that children make on the way to restricting the application of the core grammar e.g. the learning of the constraints on dative alternations (see page 77). However, Pinker's approach is fundamentally a nativist position and carries with it a number of assumptions that developmentalists are apt to question. To what extent are supposed innate predispositions really acquired configurations of more simple skills (Lehrman [1953])? Very often the only way to resolve such questions is

to carry out careful analyses of the skill involved. To his credit, Pinker has performed a very careful analysis of the verb argument and semantic structures that are involved in Baker's paradox. However, he assumes (as do many other researchers working within the field of language acquisition) that the sources of the resolution of the paradox must be laid bare in some additive fashion across different domains. If there is insufficient material to add up to a solution then it must be built in somehow. The familiar way to build in such information is to stipulate that it is innately given. On such a view, there is little room for emergent properties resulting from the interaction of two knowledge domains or even for two domains to mutually yield to the interactive molding of each other's development.

During the last few years, an alternative view of the nature of cognitive processes and their acquisition has begun to emerge. Instead of viewing mental processes as the serial manipulation of a discrete categorical symbol system, processes are viewed as highly interactive, operating in parallel with each other and knowledge is viewed as distributed throughout the cognitive system (Plunkett [1988]). Figure 5 illustrates the architecture of a simple multi-layered perceptron.

Parallel Distributed Processing (PDP) systems possess a number of characteristics that are attractive to developmentalists. For our purposes, there are three properties that are of particular importance:

- PDP systems are able to learn about the environment which they experience. In particular, they are highly sensitive to patterns of stimulation that may be extremely subtle to the casual observer.

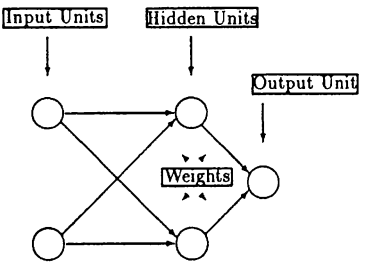


*Figure 5:* A Simple Multi-layered Perceptron

- PDP systems form internal representations of the environment to which they are exposed and use these internal representations to generalise to novel environmental situations.

- PDP systems can construct representations that coordinate information from different modalities. Internal representations with

properties that are 'emergent' with respect to the source modalities can arise.

Just as Vygotsky [1962] recognised that different pathways of development can merge together to form an 'emergent' entity that is 'greater than the sum of its parts', so can PDP systems offer the opportunity to demonstrate how information which appears not to be present in isolated modalities can emerge from a coordinated representation of several modalities.

Although PDP systems are still a long way off from fulfilling their promise, there is evidence that they are capable of solving some of the intractable problems associated with the 'poverty of the stimulus argument'. For example, Rumelhart & McClelland [1986] have shown how a simple perceptron (a parallel system without hidden units – see Figure 5) can mimic aspects of the developmental profile of English children learning past tense verb morphology. The simulation is capable of extracting from the input information both the regular pattern of past tense morphology and the exceptions to the regular pattern. Indeed, the network even produces the kind of errors that English children are observed to make during the course of development (e.g. saying 'go-ed' or 'went-ed' instead of 'went') and is able to recover from these errors just as children do. Furthermore, the network is able to achieve all this without ever being told explicitly about the rules governing the English past tense verb morphology.

Elman [1988] has shown how a recurrent network (a network containing feedback connections) can extract lexical categories from input sentences. In essence, the network learns the argument structure of the verbs in the sentences that it is presented. Thus, it constructs a representation of the type of arguments that a particular verb can take and assigns nouns to categories on the basis of the argument slots they can potentially fill. Again, all this is achieved without telling the network explicitly which items in the input sentences are nouns or verbs or what role these items should play in the grammatical structure of the sentences. Interestingly, in the process of developing a representation of lexical categories, the network passes through a period in which it 'chunks' together input words into larger units and treats them as single constituents of the sentences. This property of the network is reminiscent of the formulaic expressions of young children acquiring a language (see page 83), though of course the network does not distinguish between clearly and badly articulated utterances. In fact, this finding suggests that a formulaic phase may be an inherent characteristic of a system that is trying to uncover regularities in an input signal. In its search for patterns, the network tries out various groupings of information to decide which provide the most useful categorisations.

Chauvin [1988] has presented an auto-associative network (a network which must learn to reduplicate its own input) with the task of processing

two modalities simultaneously. The network is presented with a series of visual images and labels for those images. We might interpret the task as one in which the network is required to learn the names of objects. The object world has a prototype structure and the names categorise the 28 distinct objects into 4 different concepts. The network is successful at this task even though it is never explicitly told about the characteristics of the objects which determine their category membership. However, the network has a number of other interesting properties as well. For example, it learns to reproduce the images of objects given only the object name before it is able to reproduce the name of an object given only the image of the object. This asymmetry between labels and images in the facility with which the network can perform a pattern completion task resembles the comprehension/production asymmetry observed in the language development of young children. Furthermore, Chauvin's auto-associative network appears to undergo a »vocabulary spurt«. During the early phase of training in the net, it is rather poor at producing object labels in response to images i.e. its productive vocabulary is small and remains small over an extended period. However, rather than gradually increasing its label repertoire, the net appears to pass through a brief reorganisational phase after which it is capable of producing many labels in response to image presentations. Again, the parallel to the vocabulary development of children in the second half of their second year is clear.

The results of research with PDP systems clearly do not constitute an explanation of the detailed linguistic behaviour of young children. Furthermore, it is unclear whether they will be able to account for some of the extraordinary feats of acquisition which children regularly perform in acquiring a language. For example, how do children retreat from postulating rules like (7) (see page 78) in the absence of negative evidence? However, rather than concluding that such problems can only be solved by building the necessary information into the cognitive system, the current results of research with PDP systems suggest that many characteristics of human cognitive systems, including language, can be learnt. This is not to suggest that 'nothing is innate'. We already know that different types of network architectures have different types of learning properties. The human infant most certainly does not enter the world with an amorphous, randomly connected cognitive system. It may even turn out that different types of PDP architectures are best suited each to their own cognitive task, say language or perception. Answers to these issues will have a direct bearing on our understanding as to the nature of the mechanisms involved in language acquisition. Thus, do we require modularised networks to model language acquisition or can we make do with a single generalised learning device? At present, we do not know the answers to these questions. However, one thing is clear. In the absence of answers to such questions, we

cannot come to any conclusive position as to the exact nature of the content and structure of an innate Language Acquisition Device.

## NOTES

1. I would like to acknowledge the undaunting energy and indispensible assistance of Lone Hansen in transcribing and coding the Danish database, and Sven Strömqvist for commenting on parts of the manuscript, providing much needed linguistic insights and for filling the role of an inspiring and provocative intellectual partner.
2. This requirement is not strictly necessary but it highlights the logic of the argument.
3. Note that a circle can represent an infinite number of sentence tokens and that non-overlapping circles can represent disjunct infinite sets.
4. This issue addresses directly the problem of how the child's understanding of 'who does what to whom' becomes encoded in linguisitic structure.
5. This result is particularly noteworthy since speakers of Mainland Scandinavian languages (Danish, Norwegian and Swedish) use constructions in which the indirect object is the object of a prepositional phrase more frequently than constructions in which the indirect object is moved to the canonical (for Mainland Scandinavian languages) direct object position and the preposition is omitted (see Plunkett and Strömqvist [1990]).
6. This circumstance has prompted the emergence of public, computerised, child language data base systems such as CHILDES – the Child Language Data Exchange Scheme (see MacWhinney and Snow [1985]).
7. MacWhinney [1978] uses the term »amalgam« for expressions that the child produces on the basis of rote learning.
8. Further details of the linguistic and cognitive development of these two children can be found in Plunkett and Strömqvist [1990].
9. It makes little sense to quantify an adult's MLU since it varies considerably with socio-linguistic setting. However, a value of 4.0 would not be uncommon.
10. It is noteworthy here that Brown [1973] selected the children for his study on the basis of how easy they were to transcribe i.e. how articulate their speech was. Given the present discussion, this decision may well have biased the type of language user included in his study.

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