in humans: cortical speech zones in 100 adults and 100 infant brains', *Archives of Neurology* 32: 239–46.
Wada, J. A., and A. E. Davis (1977), 'Fundamental nature of human infant's brain asymmetry', *Canadian Journal of Neurological Sciences* 4: 203–7.
Walker, J. L. and E. S. Halas (1972), 'Neural coding at subcortical auditory nuclei', *Physiology and Behavior* 8: 1099–106.
Wasow, T. (1978), 'On constraining the class of transformational languages', *Synthese* 39: 81–104.
Weir, R. (1962), *Language in the Crib*, The Hague: Mouton.
Weiss, P. A. (1976), 'Neurobiology in statu nascendi', *Progress in Brain Research* 45: 7–38.
Wexler, K. (1978), 'Empirical questions about developmental psycholinguistics raised by a theory of language acquisition', in *Recent Advances in the Psychology of Language*, ed. R. N. Campbell and P. T. Smith, New York: Plenum Press.
Wexler, K., P. Culicover and H. Hamburger (1975), 'Learning-theoretic foundations of linguistic universals', *Theoretical Linguistics* 2: 215–53.
Whitaker, H. A. and G. A. Ojemann (1977), 'Graded localization of naming from electrical stimulation mapping of the left cerebral cortex', *Nature* 270: 50–1.
Whitaker, H. A. and O. A. Selnes (1976), 'Anatomic variations in the cortex: individual differences and the problem of the localization of language functions', *Annals of the New York Academy of Sciences* 280: 844–54.
Wickelgren, W. (1977), 'Concept neurons: a proposed developmental study', *Bulletin of the Psychonomic Society* 10: 232–4.
Witelson, S. F. (1977), 'Anatomic asymmetry in the temporal lobes: its documentation, phylogenesis, and the relationship to functional asymmetry', *Annals of the New York Academy of Sciences* 299: 328–54.
Witelson, S. F., and W. Pallie (1973), 'Left hemisphere specialization for language in the newborn: neuroanatomical evidence of asymmetry', *Brain* 96: 641–7.
Yakolev, P. L. and A. R. Lecours (1967), 'The myelogenetic cycles of regional maturation of the brain', in *Regional Development of the Brain in Early Life*, ed. A. Minkowski, Oxford: Blackwell.
Young, R. M. (1970), *Mind, Brain and Adaptation in the Nineteenth Century*, Oxford: Clarendon Press.
Zaidel, E. (1977), 'Unilateral auditory language comprehension on the token test following cerebral commissurotomy and hemispherectomy'. *Neuropsychologia* 15: 1–18.

9

Language as a cognitive system: its independence and selective vulnerability[1]

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Scholarship is the process by which butterflies are transmuted into caterpillars.

(Fodor, 1983)

Introduction

In the normal developing child the concurrent development of motor, social, cognitive and linguistic ability is a striking fact. This multiplistic character of normal development has greatly influenced theoretical models of all aspects of child development, such that most models stress the interconnections between areas of development and posit general learning mechanisms underlying the changes that occur with increasing age across domains.

Theoretical models of language development currently reflect this state of affairs, but this was not always the case. As a result of the Chomskyan revolution in linguistics, during the 1960s child language researchers concentrated on studying structural aspects of language acquisition apart from context. However, researchers soon began moving towards a focus on the larger language-learning context, identifying nonlinguistic knowledge as well as factors in the environment that are potentially important concomitants of language development. Today, some models of language acquisition stress the nonlinguistic context in which language growth occurs. The effect of this theoretical focus is twofold: (1) to view the larger developmental context in which language acquisition is embedded as the base upon which language growth can be explained; and (2) to posit nonspecific learning strategies or discovery procedures which extract the general and homologous principles underlying knowledge in several interconnected domains, including language.

This paper will argue that a different kind of language acquisition model is necessary – one which holds that the larger context in which language emerges does not explain crucial aspects of language acquisition and one which holds that the principles and constraints embodied in grammar may be unique to grammar and require a task-specific learning mechanism; i.e., one specifically designed for language acquisition.

In section 1 of this essay, I will discuss the major current models of language acquisition and their theoretical support. In section 2, I will present empirical research findings from several populations which bear directly on the issues at hand. In section 3, I will present the model of language as a cognitive system which is an outgrowth of our own research, is consistent with the findings of others and argues for a specific view of language and language acquisition. Section 4 will present summary discussion and conclusions.

1 Models of language acquisition

There does not appear to be a consensus in the field of child language research regarding what needs to be explained or what constitutes explanation. In fact the task of trying to account for how children learn to speak (or sign) and understand the language of their community has proved to be such a difficult one that the bulk of research in the field has shifted away from explanation of child language acquisition to the description of child language – a change Pinker (1984) characterizes as a shift in research emphasis from 'first order' issues to 'second order' concerns. There have been legitimate attempts to construct theoretical models of language acquisition, but these attempts reflect the lack of consensus regarding explanation. Therefore, despite these models, the basic questions of language acquisition remain essentially unanswered: (1) what is learned; (2) how input is utilized; and (3) how learning proceeds.

Perhaps the fundamental question regarding language acquisition revolves around the central puzzle of how a child changes from being in a nonlinguistic or prelinguistic state to becoming a language knower. A theory of language acquisition must make explicit the mechanisms underlying this change. In so doing, it must make explicit how a child reaches each intermediate stage (knowledge state) along the way and moves from one stage to another, eventually attaining full adult linguistic competence. An explanatory theory must also account for how a child does this on the basis of input s/he encounters and can process.

There may not be disagreement on this set of goals for a theory. But there appears to be substantial disagreement as to what set of facts and/or what knowledge the theory must account for, and therefore where to look for explanations. For some researchers the fact that language serves communication is primary. As a result, for them not only must acquisition of the rule system underlying the social–communicative uses of language be included in language acquisition theory, but an understanding of all aspects of the growing system must incorporate an explanation in terms of their functional or communicative base. To other researchers the fact that language is a cognitive system (and only one of many) is central. To these scholars, a theory of language acquisition must reflect the principles and constraints that shape the growing cognitive competence of the child, both linguistic and nonlinguistic. Explanations for the emergent linguistic system must be sought in terms of its larger cognitive base. For these two groups of researchers, then, there is a focus on nonlinguistic explanations for linguistic phenomena. For a third group, however, the linguistic knowledge of the language learner largely apart from other domains of knowledge is primary. For them explanations of language acquisition must be sought in terms of the character of knowledge eventually attained. The explanations this group seeks are largely linguistic explanations for linguistic phenomena.

The fact that nearly all children successfully acquire language and do so within a relatively short period of time supports the contention that a strong set of constraints is involved in acquisition, and most models of language acquisition propose constraints to accommodate this fact. They differ, however, in where their hypothesized constraints lie. As a result they also differ in where they place the burden of acquisition and the primary explanation for the facts of acquisition.

Three quite different theoretical approaches to language acquisition are discussed below with comments on their theoretical status.

1.1 The social/interaction model

> Language is a specialized and conventionalized extension of cooperative action. To be understood properly, its acquisition must be viewed as a transformation of modes of assuring cooperation that are prior to language.
>
> (Bruner, 1975, p. 2)

The social/interaction model (Bruner, 1975; Snow, 1972, 1977; Snow and Ferguson, 1977; Nelson, 1977; Newson, 1978) is the model formulated by those stressing that language has a communicative base and can be accounted for on the basis of its communicative substructure. The constraints that are considered by this model to be relevant to the acquisition process are external to the child. They are found in the environment in the structure of the interaction routines engaged in with the child, and in the restricted nature of the linguistic input the child receives. The major tenet of this model is, then, that there are factors and constraints

in the linguistic/communicative environment that facilitate the acquisition process and help to explain it.

The first set of factors that are stressed includes the embedding of language in social contexts that are repetitive and familiar to the child and the accompaniment to language of nonlinguistic communicative cues. The use of language in the context of familiar and frequently repeated social interactions and routines is claimed to serve several ends: it presents language as an instrument for regulating joint action and joint attention, it sets up associations between specific words and phrases and specific activities and events which in turn focuses attention on the communicative underpinnings of the code, it provides abundant opportunities for imitation and rehearsal, and it ties the use of the linguistic code to conversational settings from which to learn the basic principles of speech acts and discourse (Bruner, 1975; Snow, 1972; Keenan and Schiefflin, 1976). The use of accompanying nonlinguistic devices to signal meaning (e.g. gestures) serves as an interpretive base onto which linguistic structure can be mapped (Macnamara, 1972, 1977; Zukow, Reilly and Greenfield, 1979).

There is considerable evidence that language is indeed embedded in the kind of social/communicative contexts that this model describes. However, the basic fact of language acquisition to be explained, stated from a communicative point of view, is how a child changes from being a solely nonlinguistic communicator into a linguistic communicator as well. The proposal that these first factors comprise crucial elements in the environment does not account for this fact. The mechanisms by which these elements are used for acquisition, i.e., by which children apprehend the (correct) associations between linguistic events and social events, by which they extract the rules governing speech acts and discourse, or by which they map linguistic structures onto nonlinguistic ones must be made explicit, and they are not in this model (see Shatz, 1982, for relevant discussion). Thus the explanatory value of having identified these purportedly crucial characteristics of early communicative interaction with the child remains to be demonstrated.

The second set of factors stressed by this model deals more directly with acquisition of the linguistic code itself. It concerns the nature of the linguistic input to the child. The model stresses that primary linguistic input to children (labelled 'motherese' by Newport, Gleitman and Gleitman, 1977) has a number of special properties. It is a greatly reduced, simplified and repetitive version of the adult linguistic system, and it is modified to correspond to (perhaps be slightly in advance of) the linguistic level of the language-learner (Snow, 1972; Cross, 1977; Snow and Ferguson, 1977) so that it maximizes its usefulness to the child as a model of what is to be learned (e.g., 'intelligent text presentation' (Levelt, 1975)). The basic claim involved is that this specialized input serves as an ideal language teaching model and that its special character plays a causal role in language acquisition.

A large number of studies are descriptive of the fact that mothers and other caretakers do not talk to their young children as they would to their adult peers. Two of the key claims about the character of speech to children appear to be unfounded, however: (1) that 'motherese' is simple along some definable dimension of structural complexity; and (2) that it is 'fine-tuned' to the linguistic abilities of the child. (See Newport *et al.*, 1977; Gleitman, Newport, and Gleitman, 1982; and Wexler and Culicover, 1980, for reviews and discussion of these points as well as other aspects of this model.) Moreover, the central claim that 'motherese' plays a causal role in language acquisition has not been borne out (Schiff, 1979; Gleitman *et al.*, 1982), a finding consistent with the considerable cross-cultural differences in the character of caretaker speech to children which have been reported (Schiefflin and Ochs, 1983; Ratner and Pye, 1984).

As with the first set of factors, then, the mere identification of qualities of speech to children which set it apart from other speech does not explain how it affects language-learning. The mechanisms by which these special properties of input are recognized and utilized by the child must be proposed. In the end, sound claims concerning the effect of specific properties of input cannot be made without knowing the nature of the language acquisition apparatus.

This is not to say that certain general and even specific claims of this model will not in the long run be found to be true, apart from the obvious and undisputed assumption that the linguistic environment makes language-learning possible and has a direct influence on what is learned (e.g. which language is acquired). It is of interest, however, that in those instances in which careful research demonstrates the character of the input to have a clear effect on language learning (e.g. Newport *et al.*, 1977; Gleitman *et al.*, 1982) the findings would argue for a child-directed acquisition process rather than the environmentally-directed acquisition process proposed by the social/interaction model. However, the theoretical viability of a communicative-based explanation of language acquisition is a separate issue from the validity of the specific claims of the social/interaction model in its current form.

1.2 Cognitive models of language acquisition

> We are suggesting that there is a great borrowing going on, in which language is viewed as a parasitic system that builds its structures by raiding the software packages of prior or parallel cognitive capacities.
>
> (Bates, 1979, p. 6)

The models falling into this category stress the fact that language is only one of many cognitive systems to develop in childhood, and thus focus

on cognitive factors to explain and understand language growth. They all view language acquisition as a child-driven process. Therefore, according to a cognitivist view, the constraints implicated in language acquisition are internal to the child.

There are several different versions of cognitive models of language acquisition, each making somewhat different claims. The strongest form of those models stressing cognitive factors in language acquisition contends that language is rooted in and emerges out of nonlinguistic sensorimotor intelligence and is but one instantiation of its final stage – the attainment of symbolic–representational ability (Piaget, 1962, 1980; Inhelder *et al.*, 1972). It also contends that sensorimotor intelligence is prerequisite to language, since it is prerequisite to all forms of symbolic systems. Moreover, because language is only one manifestation of a general symbolic capacity, the same cognitive structures and operations thought to underlie other forms of symbolic thought (e.g. deferred imitation and symbolic play) are thought to underlie language. Language acquisition beyond the emergent stage is, according to this model, made possible and inevitable by the cognitive schemes and operations underlying all intellectual development beyond the sensorimotor period (Piaget, 1980). Language is thus tied to nonlinguistic cognitive function throughout its development.

Research testing this form of the model has focused on early language milestones (e.g. first words and first word combinations). It has not supported the general claim made by the model that sensorimotor intelligence is prerequisite to all aspects of language learning (see Corrigan, 1978 and 1979, for a review).

As a result of this failure, many 'cognitivists' have favoured some modified version of this model; e.g., a 'neo-Piagetian' model, a 'correlational model', or a 'local homologies' model (e.g. Bates *et al.*, 1977; Case, 1978; Corrigan, 1978; Ingram, 1978). These modified models propose that there are critical ties between language and nonlinguistic cognition based on common cognitive principles and structures, but these ties exist only between specific linguistic milestones and specific cognitive attainments. The development of these common structures yokes specific developments to each other at specific moments in development (Corrigan, 1978, 1979). Some of the relevant proposals include critical ties between sensorimotor stage VI and the emergence of single words expressing notions of location and possessor (Ingram, 1978; Bates, *et al.*, 1977), the ability to follow several invisible displacements of an object and the ability to comment on the disappearance and re-appearance of objects (Corrigan, 1978; Miller, Chapman and Bedrosian, 1977), the ability to combine two or more gestural schemes and the transition into multi-word speech (Nicolich, 1977), preoperational intelligence and metapragmatic comments (Bates, 1976), reversibility and productive nominalization and polite requests (Ingram, 1975; Bates, 1976), conservation

of continuous quantity as well as dencentrism, and comprehension and production of passives (Ferreiro, 1971; Beilin, 1975; Sinclair and Ferreiro, 1970).

One version of such a model holds that the nonlinguistic attainments are actually prerequisite to the related linguistic developments (Ferreiro, 1971; Veneziano, 1981). A second version posits only that both developments are tied, in each case by a common underlying structure (Bates, 1979). In both versions, however, nonlinguistic cognitive structures are the foundation of mental development, whether it be language acquisition or nonlinguistic cognitive growth.

The constraints governing linguistic (and nonlinguistic) development are not explained in detail by these models. Processing constraints such as short-term memory and attentional space limitations are referred to and suggested as candidate constraints impinging on language acquisition (e.g. Shatz, 1977; Case, 1978). But specific proposals regarding how these constraints actually interface with the learning apparatus of the child to predict the course of language acquisition have yet to be made. It must be recognized, however, that arguing for strong constraints on processing capacity in the child requires that the child bring to the language acquisition task powerful language-learning mechanisms in order for language acquisition to go forward and result in full linguistic competence in spite of these processing constraints.

None of these models explicates the mechanisms by which it might be proposed that language-learning takes place. All of them propose that language and at least certain nonlinguistic developments are based on shared underlying structures. This proposal necessarily implies the existence of structural commonalities or at least structural parallels across related domains. Some attempts have been made to identify such structural similarities (Greenfield and Schneider, 1977; Greenfield, Nelson and Saltzman, 1972; Greenfield 1978), with the accompanying contention that structural similarities between different domains makes language acquisition less difficult and less of a mystery. The alleged structural parallels have been found to hold true only at a general and superficial level, however (Curtiss, Yamada and Fromkin, 1979). In any case, without specifying (not just naming) the mechanisms by which children recognize (hardly transparent) analogous structural principles, it is not clear how any of the mysteries of language acquisition have been cleared up.

For a cognitive model to explain how cognitive factors can account for the fact of language acquisition, it will have to specify the nature of the internal, representational structures of children.

> The Cognitive Theory requires that children have available to them a system of representational structures similar enough in format to syntactic structures to promote language learning, and at the same time,

> flexible and general enough to be computable by children's cognitive and perceptual faculties on the basis of nonlinguistic information. Until we have a theory of the child's mental representations that meets these conditions, the Cognitive Theory will remain an unsupported hypothesis.
>
> (Pinker, 1979)

The present inadequacies of cognitive models do not imply that many of their basic tenets will not in the long run be upheld. The extent to which such models are explanatory for language acquisition, however, will depend on their explication of the child's mental apparatus which makes not only cognitive development but language acquisition possible and inevitable.

1.3 Linguistic models

> In the case of grammars a fixed, genetically determined system . . . narrowly constrains the forms they can assume.
>
> (Chomsky, 1980a, p. 35)

What I refer to here as 'linguistic' models are the models of language acquisition proposed by those for whom the ultimate achievement of full grammatical competence is the most impressive and important fact of acquisition (e.g., Roeper, 1972, 1982; Klein, 1981; Gleitman and Wanner, 1982). Guided by theoretical models of adult grammar, linguistic models of language acquisition stress the abstract, highly complex nature of the structural principles to be acquired. An underlying assumption of such models is that the richer and the more abstract and complex the knowledge to be acquired, the more tightly constrained the process of acquisition will have to be. Thus, proponents of linguistic models assert that acquisition is only possible if children come to the language-learning situation equipped with knowledge about the form of possible grammars and possible linguistic rules, knowledge that highly constrains the hypothesis space upon which inductions are made. (Notice the essential difference between this type of constraint which aids the language learner and the type of constraint proposed by cognitive models, which limits the power of the language learner.) From this standpoint, the essential questions of language acquisition (termed 'the logical problem of language acquisition'; Baker, 1979) have been crystallized into three questions a theory of acquisition must eventually answer: how acquisition happens within the boundary conditions of (1) such a short time, (2) data which vastly underdetermine what is learned and (3) no access to negative evidence to assist in learning.

Within the framework of linguistic models of language-learning, there have been two different positions regarding the nature of the acquisition process. One might best be defined as the hypothesis-generating position (e.g., Wexler and Culicover, 1980); the second, the parameter-setting position (Chomsky, 1975, 1981; Hyams, 1983; Roeper and Williams, 1987).

In the first position, the child (already armed with innate knowledge about language in general) formulates hypotheses about the structure of her/his particular language based upon the data s/he receives. To this extent, the course of language acquisition is both child-driven and data-driven. Furthermore, since full linguistic competence is acquired in a relatively short time, this position holds that the learner must be exposed to complex grammatical structures early on. (Note the difference between this position and that of the 'motherese' hypothesis, which contends that simplicity of input facilitates acquisition.)

In the second position, innate knowledge about language is assumed to be sufficiently rich so as to bias the language learner to consider only a small set of structural possibilities which differ solely in relation to particular settings or one of the predetermined set of possible instantiations of a principle of grammar. This second position places little significance on the quality or timing of the input data since the learner is hypothesized to rely very little on input.

In both positions, language acquisition is viewed as a maturationally constrained inductive process. But in the first position, some learning is thought to occur, while in the second position, learning *per se* does not take place (except with respect to a language's individual lexicon and, perhaps, some idiosyncratic properties as well). Rather, acquisition is seen as an innately specified series of choices in which options become 'fixed'. Movement from one 'stage' or grammar to another is triggered by the maturation of universal grammatical principles or 'peripheral' (nonlinguistic) mechanisms which allow for the consideration or reanalysis of key input data.

Linguistic models appear to have progressed further towards explanation than other models. They are concerned with characterizing the linguistic mental apparatus of the child to which end they incorporate constructs from linguistic theory consistent with some currently advocated formal theory of grammar (e.g., with EST (Chomsky, 1965; Wexler and Culicover, 1980); with lexical-functional grammar (Bresnan, 1978; Pinker, 1984); with government–binding theory (Chomsky, 1980, 1981, Hyams, 1983)). Acquisition research within a linguistic framework has furthermore suggested candidate mechanisms by which input data are selectively processed and used by the child to extract key language-particular information (e.g., Gleitman *et al.*, 1982; Borer and Wexler, 1984). These models perhaps more than the others, then, have addressed themselves to all three acquisition questions: (1) what is learned; (2) how input is utilized; and (3) how language acquisition proceeds. However, they

largely ignore the role that conceptual and social knowledge might play in the acquisition of a system which, after all, has two central functions: communication and representation/ideation.

1.4 The task-specificity of language

In addition to its different focus each of the models discussed makes different predictions regarding the relationship language development should hold to other aspects of development. The social/interaction model, which contends that language is communicatively-based and that the communicative environment directs the course of language acquisition, predicts that key differences in the communicative environment will result in different outcomes of language acquisition, and that we will not find children who show dissociations between linguistic competence and communicative competence. The strong cognitive model, which like the other cognitive models holds that nonlinguistic cognitive structures are the basis of language development, predicts that language will develop only after the attainment of prerequisite nonlinguistic cognitive structures. All cognitive models predict that language should be impaired to the extent that (related) cognitive development is impaired. Linguistic models entertain the possibility that language is based on unique and domain-specific structural principles whose acquisition requires a task-specific learning mechanism. This premise allows for the relative independence of language acquisition from other areas of development.

Central to these different predictions on the relationship between language and other aspects of mind is the issue of the task-specificity of language and language learning. There are basically two positions on this issue: (1) that language is based on structural and organizing principles that define other knowledge domains as well as language; (2) that language is based on structural and organizing principles that are unique to it, i.e., domain-specific. The first position implies that language is learned by a nonspecific-learning mechanism, perhaps a general inductive procedure. This position is neutral with regard to the claim that such a learning mechanism is highly constrained. It allows for the possibility that learning is essentially unconstrained as well as for the possibility that learning is a highly constrained process, perhaps even so constrained that the learning process itself shapes the character of what is learned (e.g. Newport, 1982). The second position necessitates the existence of a language-specific learning mechanism; and dictates that the mechanism be highly constrained. Otherwise, the learner could formulate too many hypotheses about language (only some of which would be true) to be ensured of learning it within a human lifetime.

Important theoretical work has appeared recently which grapples extensively with issues of learnability, in particular, language learnability (Gold, 1967; Wexler, 1977, 1982; Wexler and Culicover, 1980; Anderson, 1977; Pinker, 1987). All of this work points to the requirement that language structure be highly constrained and its acquisition similarly constrained. But while some questions of language learnability may be resolved on logical-theoretic grounds, whether language itself is based on domain-specific principles and whether language acquisition is achieved by a task-specific learning device, are questions that require empirical resolution.

Section 2 is devoted to empirical data from a variety of populations which bear on these last two questions. In so doing, they also have bearing on the models of language acquisition we have outlined above. In Sections 3 and 4 we will return to a discussion of these issues.

2 Research on the task-specificity of language

This section will present research findings on a number of different populations who shed light on the issue of the task-specificity of language and language acquisition. Some of the discussion will be on my own research and research from my lab; other portions will be on the research of others.

All of the research to be presented deals with populations who evidence the selective impairment or selective preservation of language abilities. These populations are our focus because they, more than normals or individuals who show across-the-board impairments, help to elucidate the true and necessary dependency relationships between language and other areas. To illustrate, if ability A is thought to be fundamentally tied to ability B, either in a dependency relationship wherein B would be prerequisite to A or otherwise essential for the emergence or expression of A, or in a relationship resulting from shared underlying bases or origins, then we would predict that A could not develop or remain undisrupted independent of B. To the extent that A and B consistently appear yoked, even in individuals with abnormal and uneven cognitive functioning, we have strong evidence of a true and necessary fundamental tie between them. However, to the extent that A and B can develop or be disrupted independently, we have evidence that the two may not be so tied. It is for this reason that we do not concentrate on evidence from normal populations, in whom it is quite difficult to tease apart the necessary and true from the apparent. And of course what may hold true in development may not hold true once systems have been established. For example systems that (for any number of reasons) are importantly tied during their development may become unhinged once the two systems reach their final or mature state. For this reason we will consider both developmental and adult data.

2.1 Children with selective linguistic impairment

2.1.1 'Language-impaired' children

There is a population of children who are traditionally defined as manifesting impaired language development alongside normal nonverbal intelligence, adequate peripheral hearing, no central nervous system damage affecting peripheral speech mechanisms and no significant emotional disturbance. These children are variously labelled childhood aphasics, developmental aphasics, congenital aphasics, dysphasic, language-disordered, language-delayed and language-impaired – all terms referring to the same population which I will refer to from here on as language-impaired.

Judging from the long-term standing operational definition of language-impaired children, they would appear to be an ideal population to test out hypotheses regarding the ties between linguistic and nonlinguistic development, since by definition they possess a *selective* language disability. Psycholinguistic research on this population, however, indicates that this operational definition is incorrect in two respects: (1) that this population demonstrates both nonlinguistic and linguistic deficiencies; and (2) that this group of children is not a homogeneous one.

Research of this population over the past fifteen to twenty years has painted a picture of these children as being linguistically delayed, performing like younger, normal children in their patterns of language development (Compton, 1970; Ingram, 1976: Morehead and Ingram, 1973; Leonard, 1972; Freedman and Carpenter, 1976; Bartak, Rutter and Cox 1975; Gallagher and Darnton, 1976). This work has also established that this population is indeed deficient and not just delayed in language acquisition, evidencing a protracted developmental rate, inconsistent rule use and the persistence of immature linguistic forms alongside more advanced forms (Edwards and Bernhardt, 1973, Lorentz, 1974; Johnston and Schery, 1976; Kessler, 1975). However, investigations into other areas of mental function in this population – auditory and visual perception, short-term memory, and a number of additional neuropsychological abilities – have uncovered a variety of nonlinguistic deficiencies. This has led to several different hypotheses regarding the basis for this population's performance profile. One major hypothesis has been that an impairment in auditory processing, specifically in the processing of rapidly changing acoustic information (as occurs in consonant–vowel transitions) underlies the impairments in language, auditory processing and auditory short-term memory in this population (Tallal and Piercy, 1975; Tallal, Stark and Curtiss, 1976; Stark and Tallal, 1979; Tallal *et al*, 1979a, b; Benton, 1965; Eisenson, 1972). Another hypothesis (Saxman and Miller, 1973; Stark, 1967; Furth and Puffall, 1965; Furth, 1964) has been that an impairment in sequencing ability underlies their processing, memory and language impairments. A third hypothesis has been that the deficits found in this population are the result of a maturational lag.

Still another hypothesis, one more directly relevant to the issue of the task-specificity of language, is the hypothesis which asserts that language-impaired children do not have a selective language deficit at all; that instead they have a more general representational deficit which impedes language development but which is manifest in other aspects of cognitive development as well (Kamhi, 1981a, b; Kamhi *et al.*, 1984; Morehead, 1972; Rees, 1973; Morehead and Ingram, 1973; Johnston and Ramstad, 1977; de Ajuriaguerra *et al.*, 1976).

Evidence has been accumulating that language-impaired children often have nonlinguistic representational deficits despite normal performance IQs. Two main periods of cognitive function have been investigated. In the first, sensorimotor knowledge in several domains, including means/ends, object permanence, imitation, causality, object relations in space and object/scheme relations were examined (Snyder, 1976) as well as the slightly later (preoperational) ability of symbolic play (Lovell, Hoyle and Sidall, 1968). Snyder found language-impaired children to be delayed in their means/ends knowledge (what children do to obtain objects or cause actions) and Lovell *et al.* found language-impaired preschoolers to produce less symbolic play than age-matched peers. In the second major period of cognitive growth studied, aspects of concrete operational intelligence in language-impaired children have been examined. Several studies have found deficits of figurative thought (mental projection or anticipation of a physical configuration) (Inhelder, 1963, 1966; de Ajuriaguerra, *et al.*, 1976; Kamhi, 1981b; Johnston and Ramstad, 1977; Johnston and Weismar, 1983).

These different indices of cognitive function are all abilities involving mental representation; thus, the deficient performance of language-impaired children points to representational decrements which are manifest in different ways and at different points in development.

The potential impact of such deficits on language development is great and could be explanatory of some of the specific impairments noted in the language development of this population. For example, the delay in speech onset, the protracted rate of lexical acquisition, the impoverished range of semantic functions and relations expressed and the limited propositional complexity of their speech could all be the linguistic reflections of representational and conceptual deficits. On the other hand, these indices of language impairment and the nonlinguistic deficits language-impaired children display could both be independent but concomitant reflexes of a maturational lag throughout childhood. Sophisticated research comparing the language of language-impaired children and younger 'language-matched' normals suggests the former interpretation (e.g., Johnston and Kamhi, 1982). Deep analysis of the semantic systems of language-impaired

children and younger, MLU-matched normals reveals a variety of differences between normals and language-impaired children in their encoding of simple and complex propositions, differences which argue for a discrepancy in the conceptual ability of the two populations.

These findings support the hypothesis that more general representational deficits may underlie some of the linguistic deficiencies of language-impaired children. Other findings, however, suggest that in addition to linguistic decrements which may reflect or be the consequence of nonlinguistic cognitive deficits, language-impaired children also evidence problems in language acquisition which appear to be more strictly linguistic. Careful examination of their acquisition of inflectional and grammatical morphology (or 'the closed class' as this is often referred to in current psycholinguistic literature (Bradley, 1978)) reveals acquisition difficulties (high error rate and persistent problems) which do not parallel the acquisition patterns of younger, MLU-matched peers (Weiner, 1974; Johnston and Kamhi, 1982). Their difficulties with acquisition of morphology suggest a linguistic impairment which does not have parallel or homologous reflexes in other domains.

This impairment may, however, have an explanatory basis in the auditory processing problems which have been consistently documented for much of this population (Tallal *et al.*, 1976; Tallal and Piercy, 1973; Tallal *et al.*, 1979b). There is evidence that children come to the language learning task predisposed to selectively attend to certain acoustic parameters in the speech stream (Gleitman *et al.*, 1982). Stress is one of those parameters. In a stress/accent language like English, at the earliest stages of acquisition children appear to attend only to stressed elements – stressed syllables of multisyllabic words, stressed words and syllables in word strings. Since closed-class morphology consists of unstressed linguistic material, acquisition of the closed class in English awaits the onset of a slightly later stage in acquisition when children begin to attend to less salient elements in the speech stream. Even at this stage, however, the acquisition of closed-class terms is aided by their exemplification in stressed positions (Newport *et al.*, 1977; Gleitman *et al.*, 1982). A major acoustic parameter of stress is increased syllable duration. For children with an impairment in processing rapidly changing acoustic information, therefore, stress may play an even more critical role in determining which aspects of the speech stream are accessible to the learner as input. Thus specific auditory processing deficiencies may impede the acquisition of a language like English in particular ways, the result of which is in effect an impoverished input base from which to attempt to extract the structural principles and constraints of the grammar. This possibility lends support to the hypothesis that auditory processing defects may be causal to impaired language acquisition, although only in the general sense that input is qualitatively affected and not in the ways that have been predicted,

e.g., impaired acquisition of linguistic forms that depend crucially on rapid temporal resolution (predictions which to date have not been borne out (e.g., Leonard, 1979, 1982).

Before coming to any conclusions, however, the second caveat of recent work on language-impaired children must be considered – that language-impaired children do not comprise a single, homogeneous population. They appear to represent a heterogeneous population whose disabilities may have very different etiologies and whose disabilities upon closer examination do not seem so uniform (Kamhi, 1981a, b; Tallal *et al.*, 1981; Johnston and Kamhi, 1982). There may be a portion of language-impaired children with true selective linguistic deficits; many others, however, may manifest a range of developmental dysfunctions, any one of which alone or in combination with others might impinge on the acquisition process.

Simple correlational findings between language impairment and a variety of functional decrements do not tell us whether a deficit in auditory processing or any other nonlinguistic area even exists in a particular language-impaired child, let alone if it is the cause of that child's particular linguistic problem. Conclusions about the relationship between nonlinguistic factors and impaired language acquisition await careful, longitudinal research which is sensitive to within-group differences that may be of critical importance.

In summary, then, for the moment, it is difficult and probably premature to look to language-impaired children to illuminate our understanding of the degree to which language acquisition may be tied to nonlinguistic factors.

2.1.2 Isolated children

Another population which may help us to examine language/nonlanguage dependencies is the population of children who have intentionally been raised in social isolation. Such cases enable us to test hypotheses about the necessary and sufficient conditions for linguistic and nonlinguistic growth. Only certain cases of such children provide revealing data for the issue of the task-specificity of language, however. These are cases where the language/nonlanguage profile is uneven and remains so even after several years. Cases such as these help to illuminate the separability and domain-specificity of different mental abilities.

There are three cases that meet this description. The first is Kaspar Hauser; the second, Genie; the third, Chelsea.

There is considerable disagreement as to the validity of the case of Kaspar Hauser, several writings asserting that he was an imposter and not a socially isolated child at all. There are over 2,000 documents regarding this case, however; and the vast majority of them substantiate the validity of this case and provide interesting and detailed information about Kaspar Hauser's post-isolation progress. The key sources of infor-

mation on this case were highly regarded professionals in their time with undisputed credentials (von Feuerbach, 1832; Daumer, 1832; Pietler-Ley, 1927). Additional careful research and examination of this case has been conducted (e.g. Heyer, 1964; Pies, 1966). (The reader is referred to the above sources for more information and detail.) Thus there seems to be little reason not to seriously consider these publications and the data they provide.

Kaspar Hauser was apparently isolated from the age of three or four until he was a teenager, about fifteen or sixteen years of age. He had been kept in a small room, totally isolated, supplied with food and otherwise cared for while he was asleep (or, perhaps, drugged). The size of the room prohibited him from standing erect or lying flat, and during his imprisonment he neither stood nor walked. During these years he also never spoke or was spoken to.

Upon his release and subsequent discovery in 1828, the remarkable capacity of this young man began to be revealed (and documented and described in numerous writings). He made strikingly rapid progress in almost every area. Within months of his discovery he displayed remarkable ability in drawing, memory and reasoning capacity. He lived only five years after he was found, but during that time was noted for his astonishing intellect. He was consistently reputed to philosophize about all he was learning, about life in general and about his own past. Within that short five-year period after his discovery, he learned to read and write (but see below) and became competent in mathematics and several other academic areas.

His linguistic progress, although rapid and impressive in certain respects, reportedly stood alone as the single area of mental function which remained problematic. Semantic aspects of language (German) were apparently readily mastered. Upon entering society he immediately began learning words, acquired a sizable vocabulary within a very short time (a few months) and began combining words into short 'sentences' also within a remarkably short time (again, a few months). The vocabulary he mastered and the logical wellformedness and complexity of the propositions he evidently comprehended and produced were sufficiently sophisticated to allow him to participate actively in philosophical and intellectual discussions as time went on. Yet, in contrast he displayed consistent and persistent difficulties with the grammar of German.

> to the astonishment of all,. . . he . . . very soon learned to speak, sufficiently, at least, in some degree to express his thoughts. Yet, his attempts to speak remained for a long time a mere chopping of words, so miserably defective . . . that it was seldom possible to ascertain . . . what he meant to express by the fragments of speech which he jumbled together.

> [From a later description] His enunciation of words which he knew, was plain and determinate, without hesitating or stammering. [But] in all that he said, the conjunctions, participles, and adverbs were still almost entirely wanting; his conjugation embraced little more than the infinitive; and he was most of all deficient in respect to his syntax, which was in a state of miserable confusion.
>
> The pronoun I occurred very rarely; he . . . spoke of himself in the third person, calling himself Caspar.
>
> (von Feuerbach, 1832, translated by Simpkin and Marshall)

He reportedly never mastered German syntax or morphology, evidencing a selective grammatical deficit which stood in marked contrast with his impressive intellectual abilities in all other areas, including conceptual aspects of language (here being encapsulated as 'semantics'). It is testimony to his remarkable cognitive gifts that he could communicate so effectively and at such a high level, given his linguistic deficiencies.

The second relevant case is Genie. There have been a number of published reports on the case (Curtiss *et al.*, 1974; Fromkin *et al.*, 1974; Curtiss, Fromkin and Krashen, 1978; Curtiss, 1977, 1979) and the reader is referred to these for more information. Although certain details about Genie's early life remain unknown, there is considerable information on both the case history and her life subsequent to her discovery.

Genie was isolated for a period of twelve years, from the age of twenty months to thirteen years, seven months. Her life prior to her isolation involved physical restraint and most probably malnutrition and neglect. She was born at the 50th percentile in height and weight but fell beneath the 16th percentile by her first birthday. During that same first year, she wore a physically restraining Frejka splint for seven months to correct for a congenital hip dislocation.

Beginning at the age of 20 months, however, Genie was both physically restrained and isolated. She was confined to a small bedroom in the back of the family home where she was tied to an infant potty seat by means of a harness. Left in this room for over twelve years, she was fed only infant food and received practically no visual, tactile or auditory stimulation of any kind, including little linguistic input. There was no television or radio in the home, and because of the father's extreme intolerance for noise, all speech in the home was kept to a nearly inaudible volume. Genie's brother and father were her primary caretakers, and by design, neither spoke to her.

When Genie was thirteen and a half years of age, her mother managed to escape, with Genie, from the home. Shortly afterwards Genie was discovered. She could barely walk, couldn't chew or bite, and neither understood nor spoke language.

From the time of her discovery on, Genie avidly explored her surroundings and began to show clear conceptual and intellectual progress. She quickly began organizing and classifying her enviroment (evidenced by her play activities and, a little later, by her language), and followed a course of steady growth and development. Her mental age (MA) (as measured by standard psychological measures of IQ, e.g., the Leiter International Performance Scale, the Wechsler Intelligence Scale for Children and the Raven's Progressive Matrices) increased one year for each year post-discovery. Within four years of her discovery, she had clearly attained most aspects of concrete operational intelligence including both operational and figurative thought (e.g., reversibility, decentrism, spatial rotation).

In contrast to Kaspar Hauser, Genie's mental profile was far more uneven. She demonstrated remarkable and fully developed abilities in the domain of visual–spatial function (e.g., Gestalt and part/whole abilities, spatial rotation, spatial location, conservation of spatial features and knowledge about visual–spatial features, such as size, shape and colour); but demonstrated impaired verbal short-term memory and linguistic function. Like Kasper Hauser, however, she showed a discrepancy between her acquisition of semantics, on the one hand, and her acquisition of grammatical rules, on the other.

Within a few months after her discovery in 1970, Genie began to produce single words and then acquired vocabulary rapidly. Within three to four months of her first words, she had acquired an expressive vocabulary of 100–200 words and began to combine two words at a time. Even her early vocabulary included words for colour concepts, numbers, emotional states and all levels of category membership (superordinate, basic, subordinate), including subtle distinctions (e.g., pen, marker; jumper, dress). Her acquisition of lexicon and the expression of meaning relations, including multipropositionality, steadily progressed and increased. (See Curtiss, 1977, 1981a, 1982, for more details.)

In contrast, her utterances remained largely agrammatic and hierarchically flat. Her ability to produce 'sentences' developed only in so far as she was able to produce increasingly longer strings and strings that increased in propositional complexity. Her speech, even after eight years, remained essentially devoid of 'closed-class' morphology and of most syntactic devices and operations. This dissociation between 'semantics' and syntax seen in Kasper Hauser's case, then, was a hallmark of Genie's language, too.

Genie's linguistic limitations extended to the use of language for effective interactive purposes. Her utterances were consistently well formed with regard to their presuppositional and implicative structure and generally adhered to Grice's conversational postulates (Grice, 1975). That is, Genie was sensitive to the information needs of her listener, and she was generally truthful, relevant, (always) brief and on topic. However, her means of initiating, participating in and controlling or regulating verbal interaction were greatly restricted. She possessed an impoverished set of linguistic–pragmatic devices and relied heavily on simple statements of the proposition or on repetition (of her own or others' statements of the proposition) to perform a variety of pragmatic functions – introducing topics, continuing topics, acknowledging and responding to comments, requests and questions, making comments and requests and asking questions. Moreover, she failed to use social rituals, (e.g., *Hi*, *How are you?*) or conversational operators (e.g., *Well*, *OK*) – the trappings that help to make a conversation sound normal. Thus, those aspects of effective communication depending on her appreciation of conversational content and the communicative intent and needs of her listener were least impaired, while those aspects of effective communicative interaction depending on socially conditioned skills of conversational participation were sorely deficient.

A third case involves a hearing-impaired adult, Chelsea, who is attempting first language acquisition in her thirties. Although no systematic investigation of Chelsea's language development has yet been carried out, preliminary and anecdotal data reveal a linguistic profile characterized by marked scatter in abilities (P. Glusker, C. O'Connor, V. Yancy and J. Watters, personal communication, and Curtiss, unpublished data), parallel in many respects to those seen in Kaspar Hauser and Genie. There is a striking disparity between Chelsea's lexical abilities and her ability to combine vocabulary into appropriate and grammatical utterances. Her lexical abilities have steadily progressed and are quite substantial at the time of writing. For example, in March 1984 Chelsea scored above the twelfth grade level on the Producing Word Association's subtest of the CELF, the highest norms for the test. In contrast, her multiword utterances are, almost without exception, unnacceptable grammatically and quite often propositionally unclear or ill formed as well. Thus, her lexical knowledge seems limited to (denotative) definitional cores and does not appear to encompass either subcategorization information or logical structure constraints (in contrast to Genie). Likewise, her expressive language appears, at its best, limited to the production of combinations of semantically relevant substantives.

Chelsea's discourse skills appear at least superficially to be almost the flip side of Genie's. Chelsea's topic-related skills are limited, but these limitations appear to reflect her comprehension difficulties coupled with her propositional limitations. Other discourse abilities seem remarkably developed (e.g., speech-act range, use of social rituals, use of conversational operators.)

The cases of Kaspar Hauser, Genie and Chelsea, then, suggest that there may be a critical difference between conceptual (semantic) aspects

of language, on the one hand, and rules of grammar (here syntax and morphology), on the other. This critical difference has two potential (related) bases. First, the learning capacity they displayed and utilized for other intellectual domains was insufficient and/or inappropriate for learning grammar. In Kaspar Hauser's case, even extraordinary intellect was not sufficient. Second, the learning principle(s) which can learn grammar were either selectively impaired from birth, or, by the time they were discovered, Chelsea, Genie and Kaspar Hauser had passed the age at which they were still functional. In Genie's case, she is reported to have begun talking before she was isolated, suggesting that, in her case at least, language learning was proceeding normally before it was interrupted. In any event, both of these explanations for the selective linguistic deficits these cases displayed point to a task-specific grammar acquisition ability. Their cases further suggest, however, that not all aspects of language may require task-specific abilities. In Genie's and Kaspar's cases, lexical and propositional semantics developed with apparent ease, reportedly reaching a higher level in Kaspar Hauser's case than in Genie's. This area of language at least, then, appears to be accessible to other learning strategies or developmental principles. The rate and level of mastery of lexical and propositional semantics may furthermore reflect or be tied to nonlinguistic conceptual and intellectual ability. This possibility, however, leaves unexplained Chelsea's problems with propositional form, suggesting that lexical semantics and propositional semantics may be differentially vulnerable to age at acquisition, with lexical semantics the more resilient of the two.

The effective use of language for communicative purposes is a less clear matter. Genie's case suggests that those parameters of communication tied to the needs and intentions of the listener may depend for their development on the cognitive abilities of the child; whereas those parameters of verbal communication which reflect culture-specific phrases and routines (topic introducers, request forms, forms of acknowledgements, etc.) are tied to the social development of the individual.

An additional aspect of Genie's and Chelsea's cases may relate to the task-specificity issue. A series of experiments has been run on both cases to determine cerebral dominance for language. Chelsea and Genie are both right-handed, thus the 'normal' or expected results would have shown left-hemisphere specialization for language. In Genie's case, these experiments used dichotic listening and event-related potential (ERP) paradigms (Kimura, 1967; Shankweiler and Studdert-Kennedy, 1967; McAdam and Whitaker, 1971; Wood, Goff and Day, 1971). (See Curtiss, 1977, for a description of the experiments and details of the results.) The results were dramatic. In each case (seven experiments in all) the results indicated that Genie's *right* hemisphere was dominant for language processing to a degree that paralleled those individuals who have only one hemisphere or whose hemispheres have been surgically disconnected (Zaidel, 1973, 1974).

In Chelsea's case initial ERP testing in 1983 revealed a marked right-hemisphere advantage for verbal material; one year later no hemispheric asymmetries were revealed (H. Neville, personal communication).

These results raise the possibility that language- (grammar-) specific learning mechanisms may be tied to the left hemisphere in (right-handed) normals (see Curtiss, 1981b, 1985, for a discussion of this issue). Evidence supporting this possibility comes from the next group of children with selective linguistic impairments to be discussed; hemiplegics and hemidecorticates.

2.1.3 Childhood hemiplegics with and without hemidecortication

The children to be discussed in this section are children who have suffered prenatal, perinatal or childhood left-hemisphere lesions. One group of children had surgical removal of the diseased hemisphere; the other group did not.

The first group we will discuss are children who acquired unilateral lesions of the left hemisphere before or at birth. Such children, who retain both hemispheres and who therefore develop with one diseased hemisphere, are commonly referred to as hemiplegic. A number of studies on hemiplegic children are well known in the literature (Basser, 1962; Annett, 1973; Bishop, 1967; Hood and Perlstein, 1955), but only one study presents detailed information on the language and nonlanguage abilities of their subject population (Rankin, Aram and Horwitz, 1980). We therefore rely on the data presented in the Rankin *et al.* study for our discussion of this population.

Rankin *et al.* report on three children who sustained left-hemisphere lesions. Seven separate measures were used to assess language ability (two phonology, two lexical and three syntax tests), and the Leiter International Performance Scale was used to measure nonverbal intelligence, At the time of testing, the children were six to eight years old, average age 7,11.

All three children showed intact ability (or equivalent ability to the children with unilateral right-hemisphere damage) on the phoneme discrimination and expressive lexicon tests. On all of the other linguistic measures, however, the left-hemisphere-damaged children were impaired, with their most severe decrements in comprehension of syntax. All three of the children also showed delayed onset of one- and two-word speech. With one exception, all of the children in the study, both left- and right-damaged had below average Leiter scores; but the left-hemisphere-lesioned children showed slightly greater deficits in MA.

The findings of this study indicate right-hemisphere deficiency in

language acquisition and performance. The linguistic areas least impaired under right-hemisphere control were phonology and lexical semantics, although even these areas showed some decrements. Greatest impairments were displayed in receptive syntax.

The second population we include here is a group whose linguistic abilities have been studied in great detail (Dennis and Kohn, 1975; Dennis and Whitaker, 1976; 1977; Dennis, 1980a, b). They are ten hemidecorticate children, one group of which had Sturge-Weber syndrome and whose left hemispheres were removed within the first year of life to control perinatal seizures, the second group of which also sustained cortical pathology within the first year of life, but whose left hemispheres were removed later in childhood.

In a series of studies Dennis and her colleagues have systematically studied IQ, cognitive skills and language abilities in all of these children. At each data collection point (during the eight-year period of study), IQ and almost all cognitive skills were equivalent in both left and right hemidecorticates. The exceptions to the impressive similarity in mental abilities are in the area of visual–spatial function, where the left hemidecorticates outperform the right, and in language, where the right hemidecorticates outstrip the left.

Both the semantic and syntactic abilities of this population have been studied with considerable sophistication. No differences were found in the receptive or expressive lexical semantic abilities of the two groups. In addition to equivalent levels of performance, no differences between the groups were found in the apparent processing strategies utilized for word access or retrieval. Thus both hemispheres appear equivalently able to acquire the sense and referential structure of at least common words. The one exception was that the left hemidecorticates but not the right evidenced problems using rhyming cues to access words (the only phonological operation tested). Thus the two hemispheres, though equivalent in their phoneme discrimination and production abilities, may be unequal in their ability to perform phonological or metaphonological computations.

Relational and propositional semantics also do not appear to be similarly developed in both hemispheres, however. The structure of interrelationships between words, apprehended in part on the basis of the componential structure of word meaning, appears less tightly organized and less well integrated with other aspects of linguistic structure. For example, the meaning of a word is partly defined by sentence context; yet extracting semantic information involving conceptual focus (information typically signalled by surface syntactic structure and sentence intonation patterns), determining grammatical and thematic relations in passive sentences, and defining scope domains for negation are all reportedly inadequately and inefficiently performed by the right hemisphere. As a consequence, 'semantic processes', even when they hinge directly on word meaning (as with entailment or implicature) are also affected and impaired in the right hemisphere.

Syntactic deficits are equally apparent in the right hemisphere. Left hemidecorticates take longer to discriminate all sentence types, are poorer at sentence repetition and poorer at comprehension of 'complex' syntactic structures. In addition, the two hemispheres appear to process sentence structure differently, even for structures they can both interpret correctly.

These hemidecorticate findings suggest two conclusions. First, like the hemiplegic cases discussed above, the hemidecorticate cases indicate that the right hemisphere is inferior to the left as a language learner. The right hemisphere shows deficits in phonology, syntax and semantics. In this population, as with others we have discussed, though, word-level semantic abilities appear well developed. Secondly, these cases suggest that the right hemisphere may utilize different processing strategies from the left hemisphere to encode and decode syntactic structures. If true, this would indicate that the right hemisphere differs from the left in both capacity and strategy for linguistic function. And this is true despite equal intellectual capacity of both hemispheres. These cases thus suggest that language acquisition requires task-specific ability, that this ability is tied to the left hemisphere and that the right hemisphere utilizes its own processing 'strategies' for language, despite their inadequacies.

2.2 Adults with selective language impairments

The main population falling into this category is adult aphasics – those individuals whose language functions have been lost or interrupted by acquired brain damage. Aphasics are classically divided into several categories: those with a global loss of language, those whose primary deficits lie in expressive language, those whose primary deficits are in both production and comprehension of meaning, those whose primary deficit is in repetition and those whose primary deficit is in word finding (Heilman and Valenstein, 1979; Hecaen and Albert, 1978). (We omit the transcortical aphasias and a number of disorders related to aphasia, such as alexia and agraphia). One can see even from this gross classification that language does not typically fall apart 'of a piece'. Its disruption by brain damage reflects its modular structure, and various aspects or components of language can apparently be disrupted quite separately.

The primary issue of interest for us here, however, is not what aphasia reveals about the structural character of language. Rather, it is the extent to which language as a cognitive system can be selectively impaired, that is, impaired independently of other mental abilities.

There are two opposing neuropsychological positions on this question: one position holds that aphasia is basically a 'loss of abstract attitude' (Goldstein, 1948), a symbolic deficit (Lichtheim, 1885; Kussmaul, 1884;

Brown, 1977; Head, 1926). According to this view, a loss of language necessarily implies a loss of intelligence, for language is crucially a reflection of symbolic thought. A second position holds that language *can* be disrupted independently of other cognitive functions (Chomsky, 1976; Kean, 1977; Benson and Geschwind, 1972). According to this view, the mind is a modular network of mental faculties. Each module or faculty can be impaired separately. When areas of the left hemisphere near the language zones subserve one of these nonlinguistic faculties of mind, some aphasics may suffer extralinguistic cognitive losses. But these co-occurrences would be artifactual of anatomical topography, not reflective of shared psychological bases. Unfortunately, there are only scanty data which speak to the issue.

The first type of 'data' which can be mentioned is hardly the result of systematic research. It is essentially the theoretical picture growing out of more than a century of documented behavioural deficits resulting from brain damage. The 'data' in question are the separate existence of the syndromes of aphasia (loss of language) and agnosia (loss of apprehension). Although the two syndromes can of course occur together, there are abundant documented cases involving selective losses not just of language (the aphasias) but of recognition and apprehension in various domains (e.g., the domain of objects, colour, music, space, body-scheme, all visual information or all auditory information). A variety of other selective deficits has been documented as well – in constructional praxis, in arithmetic, in visual-spatial ability and more. The hypothesis resulting from such data is that intelligence can be thought of as divisible into separate domains or components, each of which can be disrupted, even lost. Although language and the other knowledge domains may be localizable within the brain, 'general' intelligence *per se* cannot be; only individual components of intelligence can be. And since normal intelligent behaviour involves intimate and complex interaction between different domains, intelligence itself, as a psychological construct, refers to the entire complex of intelligence domains. Again, the evidence for this view is the collection of cases documented and reported throughout the last century, which describe the selective occurrence of the agnosias and other losses apart from the aphasias and vice versa.

The second kind of data we can discuss comes from studies of nonlinguistic cognitive function in aphasics (see Zangwill, 1964; Bayles, 1979; Hamsher, 1981, for reviews). Such studies provide a confusing and conflicting picture. Many aphasics display nonlinguistic cognitive deficits; many do not. Perhaps the strongest indication of intact symbolic function despite aphasia comes from a study conducted by Glass, Gazzaniga and Premack (1973). They successfully taught global aphasics (those with severe and global language losses) an abstract and arbitrary symbol system which coded relationships between objects and between objects and attributes. The aphasics not only learned the arbitrary reference for individual symbols and meaning relations between them, they learned to use these symbols in a set of rule-governed combinatorial operations, and did use them for communicative as well as task-fulfilment purposes.

Other data are not so clear cut. However, two factors associated with aphasia appear to play a significant role in determining whether or not aphasia is accompanied by intellectual deficits. The first factor is locus of damage. Aphasics with damage in areas other than frontal lobe show cognitive losses more often than aphasics with frontal lobe damage (see e.g., McFie and Piercy, 1952; Hamsher, 1981). The second factor is the presence of receptive language impairment in the aphasic breakdown. Aphasics who have a substantial impairment in language comprehension demonstrate nonlinguistic intellectual deficits more often than aphasics with good receptive language performance (Spinnler and Vignolo, 1966; Archibald, Wepman and Jones, 1967; Zangwill, 1969; Hamsher, 1981). One nonlinguistic hypothesis to explain this fact (Varney, 1980) is that impairments in the comprehension of spoken language may involve both linguistic and nonlinguistic semantic (conceptual-) associative breakdowns.

By a combination of these factors, posterior aphasics with impaired comprehension should be expected to evidence nonlinguistic cognitive impairments most often, and this appears to be the case. Such aphasics typically have fluent, structurally rich, but often relatively contentless speech. Recent studies of the semantic abilities of such aphasics reveal impaired lexical knowledge which can perhaps best be characterized as a breakdown in the semantic-associative structure of word meanings (Lhermitte, Derousne and Lecours, 1971; Howes, 1967; Goodglass and Baker, 1976; and see Caramazza and Berndt, 1978, for a review). These data indicate that those individuals with comprehension problems and semantic deficits may be at special risk for extralinguistic intellectual losses; these data also suggest an important tie between semantic knowledge and nonlinguistic conceptual and intellectual ability, a tie which does not implicate the grammatical, computational aspects of language.

In summary, both developmental and adult data suggest that there are some nontrivial ties between lexical semantic plus certain aspects of propositional semantic abilities, and nonlinguistic cognitive sophistication. Phonological knowledge, knowledge of the 'closed class' and syntactic principles, appear to constitute a separate domain of linguistic knowledge, however, not tied to nonlinguistic function in the same way or to the same extent. Left hemidecorticates and hemiplegics, and Genie and Chelsea further suggest that this separate domain of linguistic knowledge may be the special property of the left hemisphere. Thus, the data on selective impairments in language support the notion that acquisition and maintenance of at least certain aspects of language involves task-specific principles.

2.3 Individuals with selectively preserved language abilities

If the acquisition and maintenance of at least certain aspects of language is a domain-specific affair, then it should in principle be possible to find evidence for their selective preservation. That is, it should be possible to find children who demonstrate selectively preserved language acquisition despite other deficits, and adults who demonstrate selectively preserved linguistic ability despite other cognitive losses. This section will present evidence that such children and adults do exist.

2.3.1 Children with selectively preserved linguistic abilities

The extent to which language acquisition may be based on task-specific mechanisms has been the focus of research in our laboratory for some time (e.g., Curtiss, Kempler and Yamada, 1981; Curtiss, Yamada and Fromkin, 1979). Below I will present data from several case studies we have conducted. These case studies involve children who are mentally retarded but who have surprisingly intact linguistic function despite their pervasive cognitive deficits. We have data from several such cases; three of them are discussed below. In two of the three cases the etiology of the retardation is unknown.

Each of the children to be discussed was the subject of an in-depth study examining both language and nonlanguage abilities. Comprehension and production of morphology, syntax and semantics was assessed in detail, as was conversational skill. Nonlinguistic assessment included testing and observation of short-term memory, logical reasoning, visuo-construction, play, drawing, classification, seriation and number concepts. (See Curtiss, Kempler and Yamada, 1981, for a full description of the methodology involved.)

The first child is Antony, a child of six–seven when we studied him (see Curtiss and Yamada, 1981, for a detailed description of the case). Antony's IQ estimates ranged from 50 to 56. At CA 5;6 his MA was 2;9. Parental reports indicate speech onset at one year, and full sentences at three years, despite numerous professional reports of pervasive developmental delays in many areas.

We found in Antony's language a profile quite the opposite of Genie's. Antony's language is well formed phonologically and structurally rich. It is fully elaborated with 'closed-class' morphology and includes syntactic structures involving movement, embedding and complementation. Its strengths, therefore, lie in phonology, syntax and morphology. Antony's language is semantically quite deficient, however. His lexical specifications are incomplete; sometimes inaccurate. This results in incorrect word usage, one problem frequently leading to miscommunications with others. Propositional content, unless quite simple, is also often confusing and incompletely expressed. He frequently fails to grasp the presupposition and implicature of his own and others' utterances, causing consistent communication failures. Antony's language is therefore well formed generally only out of context.

Antony's conversational abilities include a wide range of pragmatic functions and intentions (e.g., naming, turn-taking, commenting, requesting, protesting, responding to requests and questions and acknowledging), and he has learned the conventional means for expressing them (rejoinders, words and phrases of acknowledgement, request phrases, etc.). He is not, however, sensitive to the needs of his listener. His topic maintenance skills are poorly developed, and he rarely appears to be concerned with being relevant or informative.

It appears that Antony has acquired the grammatical system separate from the semantic structures which are mapped onto sentences by means of the grammar, and separate from the rules guiding the use of grammar for effective communication. To the extent that this is true, he may be said to have acquired an autonomous syntax.

Antony's nonlinguistic profile reveals a further dissociation of grammar from other abilities. In structured and unstructured situations his attention span is markedly short. Many tasks we successfully administered to normal two-year-old children proved too difficult for Antony to grasp. On those tasks for which he was able to give a measurable performance, he showed substantial deficiencies in every area except auditory–verbal short-term memory. His drawings were prerepresentational; his play was at the one–two year level; he was unable to perform any of the classification tasks; his logical reasoning abilities were at the two-year level. His nonlinguistic cognitive level appeared to be at or just beyond sensorimotor stage VI (normally attained at approximately 20–24 months), with nonlinguistic symbolic abilities (e.g., play, drawing, copying) below that. His one area of nonlinguistic strength is auditory–verbal short-term memory, in which he performed *above* age level.

The second case is Marta[2], a teenager studied from the age of sixteen–eighteen (Yamada, 1981; 1983). Marta's IQ estimates range from 41 to 44. All developmental milestones are reported to have been delayed, including speech onset and other linguistic developments. From the age of about four–five years, however, language clearly stood apart as Marta's area of greatest strength.

Marta's linguistic profile is much like Antony's. Her speech is well-formed phonologically, is fully elaborated morphologically and embodies rich and complex syntactic structures. Like Antony, she produces errors, demonstrating that her utterances are not merely (delayed) repetitions of someone else's speech, but her utterances are generally much longer and propositionally more complex and convoluted than Antony's, as illustrated in the examples below. In addition, her lexicon is much richer and

contains many more quantifiers and adverbs than Antony's, as is also illustrated in the examples below.

Samples of Antony's speech	*Samples of Marta's speech*
Do you got a brother?	It's down the street in a house my second home 'n my mother is really sworn.
I don't want Bonnie coming in here.	Last year at (name of school) when I first went there three tickets were gave out by a police last year.
I don't know who he gots.	She, does paintings this really good friend of the kids who I went to school with last year and really loved.
I want to see who's in that class.	He won't even recognize until you see his bangs are cut.
I would not have an ice cream.	The police pulled my Mother an' so I said he would never remember them as long as we live!
I don't got friends, I got my brother named David.	Well, we were taking a walk, my Mom, and there was this giant, like my Mother threw a stick.
I doed this already.	I haven't shown you my garage yet, but Dad would be really hard.
That's tying his shoe.	We should go out an, um go out, and do other things.

Although Marta has a larger vocabulary than Antony, their lexical–semantic abilities are quite parallel. Much of Marta's lexicon is incompletely specified, not for grammatical features, but for semantic features involving sense reference. Thus, she, too, often misuses words, most frequently words referring to number, time, manner and dimensionality. The propositional content of her utterances, though apparently rich and varied when only a small sample of her speech is considered, is largely repetitious of a small repertoire of themes and at its best is loosely structured.

Her conversational performance is strongest in those areas incorporating conventionalized social routines and early developed (Dore, 1978) pragmatic functions, weakest in the areas of topic maintenance, relevance, informativeness and truthfulness. Marta, too, then, appears to have an advanced level of grammatical knowledge alongside dramatically less-developed semantic and pragmatic ability.

Marta's nonlinguistic performance shows further dissociations between grammar and other knowledge domains. She lacks almost all number concepts, including basic counting principles; her drawing is repetitious and at a preschool level; her play behaviour is limited – symbolic play noted on one occasion; her auditory–verbal memory span appears to have an upper limit of three units, and logical reasoning and operational thought is at an early preschool level. Unlike Antony, she does not appear to have *any* area of strength or well-developed ability in her nonlinguistic profile. She does, however, appear to have some conscious cognitive appreciation of language as an object of contemplation in its own right; i.e., metalinguistic ability. On imitation tasks, she is able to both detect and correct surface syntactic and morphological errors and at times to detect semantic anomalies as well. In addition, she is sensitive to foreign accents and often makes comments about such accents or the use of a foreign language (e.g., 'They're speaking Spanish, can you hear it?', 'the mother's accent spits right out the mouth'). Thus, Marta has not only acquired remarkably developed grammatical knowledge in contrast to all other aspects of mental ability, that knowledge has developed beyond the stage of unconscious acquisition to a stage allowing for some conscious awareness and manipulation.

The third case is Rick, a mentally retarded fifteen-year-old who suffered anoxia at birth and evidenced pervasive developmental problems throughout his childhood. Rick was institutionalized most of his life in a state hospital for the severely retarded.

Rick's language profile is quite parallel to the other two cases – well-developed phonological, morphological and syntactic ability alongside poorly developed lexical and propositional semantic ability. In addition he makes frequent lexical errors and occasional morphological errors, both indicating that at least much of his speech is novel and productive. However, he also makes frequent use of a small set of phrases in combination with novel phrases giving his speech over extended discourse periods, a somewhat repetitious quality. Some examples of his speech are listed below.

Samples of Rick's speech

He's the one that plays around like a turkey.
You already got it working.
If they get in trouble, they'd have a pillow fight.
She's the one that walks back and forth to school.

She can get a ponytail from someone else.
It was hitten by a road; but one car stopped and the other came.
She must've got me up and thrown me out of bed.
I find pictures that are gone.
Would you please give me the trashcan?

Rick is an extremely social child and has well-developed interactive linguistic skills. He makes appropriate use of social rituals and other conventionalized conversational forms. His semantic deficiencies impede his communicative effectiveness, however, since he often misinterprets or fails to understand the presuppositions or implicature of utterances directed to him and often makes lexical and propositional errors of his own. He thus shows the kind of linguistic/pragmatic profile that Antony and Marta have – a highly developed grammatical system coupled with impaired semantic knowledge and pragmatic skills reflecting sensitivity to the needs of the listener.

Rick's nonlanguage profile is most similar to Antony's, although Rick is more readily testable. Rick's drawing and copying were prerepresentational. He can rote count to twenty and knows some of the basic counting principles, but can count correctly only set sizes up to five, and his number reasoning is primitive. His classification abilities were at the two–three-year level, and his logical reasoning and operative thought performance was also at an early preschool level. In contrast, he performed at the six–seven-year level in auditory–verbal short-term memory.

All three of the children performed very poorly on tests of language comprehension. They had difficulty attending to more than one picture at a time and choosing between them. These attentional and cognitive limitations contributed to their severely impaired comprehension performance, which stood in marked contrast to their well-developed expressive grammatical ability. This profile of good expressive grammatical ability coupled with impaired comprehension performance parallels that of fluent aphasics. It is interesting in this light that those aphasics with poor comprehension despite good expressive ability are those who most frequently demonstrate nonlinguistic intellectual deficits. This finding, together with the data from the three cases just discussed, suggests that the functional independence of grammar may hold more fully, or perhaps exclusively, for language production.

Antony, Marta and Rick show striking dissociations between knowledge of grammar (rules of phonology, morphology and syntax) and conceptual aspects of language (semantics), and between grammar and nonlinguistic cognitive abilities. Antony's and Rick's auditory short-term memory abilities were higher than any other nongrammatical area, but Marta's auditory short-term memory performance was as deficient as the rest of her cognitive profile; thus good auditory short-term memory

cannot be a requisite for acquiring expressive grammatical ability. These cases are consistent with the suggestion presented earlier (2.1.2) that there is a close tie between lexical and propositional semantic development and nonlinguistic cognitive level. These cases further complement Genie's and Chelsea's data on pragmatic abilities, providing additional evidence that communicative functions related to meeting the needs of one's communicative partner may be linked to cognitive level, whereas other communicative devices may be yoked to social development and social intelligence. Evidence that communicative ability, in any case, rests on different knowledge than grammar comes additionally from a case study by Blank, Gessner and Esposito (1979) in which a child developed structural knowledge of language in the absence of almost all communicative skills. Acquisition of structural linguistic knowledge in the absence of communicative skills is also reported for many schizophrenic and autistic children (Kanner, 1943; Elliott and Needleman, 1981; Goodman, 1972). Our data demonstrate for the first time, however, the acquisition of considerable structural knowledge of language without the support of concomitant conceptual and cognitive growth.

One additional developmental population worth mentioning is Turner's syndrome. Turner's syndrome is a chromosomal anomaly with a pathological variation in the short arm material of the second X chromosome (Silbert, Wolff and Lilienthal, 1977). Turner's individuals are phenotypically female and have one or more of a set of physical stigmata including short stature, skeletal abnormalities, webbed neck, coarctation of the aorta and gonadal dysgenesis.

This population has been reported to have a variety of nonlinguistic cognitive deficits including visual–spatial impairments and decrements in numerical reasoning, digit span, auditory figure–ground and rhythmic memory (Money 1964; Silbert *et al.*, 1977; Shaffer, 1962). Although there has been no published developmental or detailed linguistic study of this population, they are almost universally reported to have normal language ability – this, despite their deficits in auditory and serial processing and in verbal operations. Our laboratory conducted a series of case studies of children with Turner's syndrome to determine if the reported profile of normal language development alongside selective cognitive deficits would be upheld after careful linguistic analysis.

We found five of the six children we studied to have normal or advanced language, in spite of a range of other cognitive deficits (see Yamada and Curtiss, 1981, and Kempler and Curtiss, 1982, for more details). Furthermore, one of the cases showed the kind of marked discrepancies between grammatical knowledge and nonlinguistic cognitive knowledge that we have found in other children (Yamada and Curtiss, 1981). Most interesting, however, was that each of the children displayed deficits in different cognitive domains. That is, they each had a unique

cognitive profile with a different set of peaks and valleys. These cases not only provide evidence for the independence of language from a variety of nonlinguistic areas in development, then, they suggest domain-specific principles in domains outside of language.

2.3.2 Adults with selectively preserved language

The extent to which language may be preserved despite substantial nonlinguistic cognitive losses may best be demonstrated by cases of dementia. Dementia is a loss of intellectual function typically characterized as the result of diffuse cortical atrophy (Heilman and Valenstein, 1979; Cummings, Benson and LoVerme, 1980). It is a term actually encompassing a number of diseases (e.g., Pick's disease, Alzheimer's disease, multi-infarct dementia, subcortical dementia), all of which are alleged to have in common the deterioration of a variety of abilities. Most common among these abilities is the loss of memory and attention capacity, but a common behavioural definition is loss in at least three of the following areas: language, memory, visual–spatial skills, personality and cognition (abstraction and mathematics) (Cummings *et al.*, 1980).

With few exceptions, the literature on dementia provides only a general assessment of linguistic abilities. A few studies, however, are beginning to build a more detailed picture of language function in dementia (Schwartz, Marin, and Saffran, 1979; Irigaray, 1973; Nichols, Obler, and Albert, 1982; Whitaker, 1976; Bayles, 1982, 1983). It is these studies that will serve as the basis for the discussion to follow, including some of the data we have been collecting in our laboratory over the past year (Curtiss, Kempler, and LaRue, 1981; Kempler, 1984; Kempler and Curtiss, 1983).

Schwartz *et al.* report a case study of a woman with progressive degenerative dementia. They systematically assessed her lexical semantic, syntactic, and phonological (through reading) abilities. They found a pattern of marked lexical semantic loss alongside preserved syntactic and phonological abilities. The lexical loss appeared tied to a progressive deterioration of the referential substructure of word-meaning, with 'lower-level', more specific features of word-meaning lost before 'higher level' more general features. This progressive decline appeared related to a decline in conceptual knowledge and processing. Data consistent with the Schwartz *et al.* findings come from a study of three cases (Warrington, 1975) which also demonstrate a selective lexical loss associated directly with deterioration of the related nonverbal concepts.

Further evidence for the dissociation of phonological and syntactic from semantic (and pragmatic) ability has been found in a detailed linguistic study of a mixed transcortical aphasic with presenile dementia (Whitaker, 1976), and in our own research on dementia.

In our own work focusing on dementia of the Alzheimer's type (DAT), we have systematically investigated semantic, pragmatic, and syntactic

production across different tasks, including spontaneous speech. We have found that syntactic knowledge and the ability to use it in production is uniformly relatively preserved, whereas semantic and discourse abilities deteriorate over the course of the disease. We have also found that a disintegration of propositional integrity and cohesion accompanies lexical-semantic loss (Kempler and Curtiss, 1983). What is more, lexical-semantic disintegration is accompanied by parallel symbolic impairment in another domain (gesture) (Kempler, 1984).

These findings on dementia suggest that phonology, morphology and syntax may be functionally dissociable not just from lexical knowledge, but from a considerable portion of the semantic system as a whole and from a major component of discourse knowledge. Moreover, Kempler's work supports the tie between lexical-semantic and symbolic abilities in other domains. Once again we find support for the view that grammar is a separate cognitive system based on organizing principles and perhaps neuropsychological mechanisms which are unique to it.

3 A model of language

The research summarized in section 2 points to several conclusions, including: (1) that grammar (rules of phonology, morphology and syntax) is based on domain-specific cognitive principles; (2) that both in acquisition and in breakdown grammar may be functionally independent from lexical and propositional semantics and from pragmatics; (3) that both in acquisition and in breakdown grammar may be independent from nonlinguistic domains of intelligence; (4) that knowledge of grammar is mediated principally by the left hemisphere, both in acquisition and in maintenance; (5) that lexical and propositional semantic abilities are tied to nonlinguistic conceptual and cognitive function; (6) that language comprehension may be linked to aspects of intellectual ability not required for language production.

A model of language should be consistent with these findings. I propose, therefore, a tripartite model of language (much as in Curtiss, Kempler and Yamada, 1981) wherein language is composed of at least three separable components: (1) a grammatical component, (2) a referential/propositional component, and (3) a social/communicative component. The grammatical component includes the rules of phonology, morphology and syntax and is an autonomous system of knowledge. The referential/propositional component includes knowledge of lexical specifications, functions and relations and knowledge of propositional form and relations. This component necessarily intersects with conceptual knowledge, the system of object-reference and knowledge of logical form. The social/communicative component includes the rules governing the use

of language for communicative purposes. This component necessarily intersects with the rule system governing nonlinguistic communication and social interaction.

Characterization and specification of the grammatical component is the task of linguistic theory, and a theory of language acquisition must incorporate the results in order to account for what is learned. A full understanding of the other two components will require the contributions of both cognitive psychology and sociology, at least, and acquisition theory accounting for the acquisition of these two components must appreciate their multiplistic character.

This model builds upon the model explicated by Chomsky (1980c) and incorporates several of the same assumptions. In Chomsky's model language is divided into two primary components: (1) the computational component (the rules of grammar) and (2) the conceptual component (the rest). Like Chomsky's model, this model assumes that grammar is computational in character, and like Chomsky's model, our model assumes that each component is based on distinct principles. Unlike Chomksy's model, however, we divide the conceptual aspects of language from the communicative aspects, using the data from (abnormal) acquisition and breakdown to support this division.

4 Summary discussion and conclusions

4.1 Discussion

The social/interaction model asserts that language is communicatively based, that factors in the communicative environment guide and determine the course of language acquisition and that the linguistic system is learned on the basis of the rules governing the social/interactive use of language. Cognitive models assert that language is a reflection of and bound to nonlinguistic cognitive development, and that language and at least some nonlinguistic abilities are based upon common structural principles. Linguistic models assert that language acquisition is possible only if children are equipped with considerable innate knowledge about language; it thus is not tied to the nonlinguistic learning capacity of the child. They furthermore assert that what is learned may be characterized by autonomous or domain-specific structural principles.

The data we have reviewed above demonstrate the untenability of all three of these models in their 'pure' forms. First, all of the data we presented point to an unshakable tie between lexical and propositional semantics and conceptual/cognitive knowledge. This tie appears to hold both in development and in mature functioning, regardless of the population and regardless of the preservation or impairment of other aspects of linguistic function. The evidence for this tie is all the stronger since it

emerges in an attempt to elucidate the separability of language from other aspects of mind. And, it is inconsistent with linguistic models of acquisition which do not specify or even recognize a special relationship between at least this one major aspect of language and nonlinguistic knowledge.

Second, the data from dementing elderly, and from Genie, Antony, Marta, Rick, and other populations we have only referred to (e.g., autistics and the case of Blank *et al.*, 1979), indicate that knowledge of linguistic pragmatics is separable from knowledge of grammar, but is yoked in different ways both to social–communicative knowledge and to nonlinguistic cognitive knowledge. Genie's and Chelsea's cases, in particular, suggest that knowledge of the linguistic conventions for coding communicative intentions and socially contingent responses is acquired through social experience, and neither depends on nor is the source for other aspects of linguistic knowledge. Data from Genie, Antony, Marta, Rick and dementing elderly suggest a separation of this experientially tied aspect of pragmatic knowledge from 'topic maintenance' aspects of pragmatic knowledge, which appear to be tied specifically to cognitive awareness of the needs of one's communicative partner. As our data reveal that both aspects of pragmatic ability are demonstrably independent of grammatical knowledge, the data fail to support the social/interaction model. Experience of the rules governing the social/interactive use of language appears to be the basis for learning just that, the rules governing the social–interactive use of language, not the rules of grammar. The communicative function of language appears not to coincide with or explain the structural principles of grammar or its acquisition.

Third, all of the data we presented point to a dissociation of phonology, syntax and morphology from both semantics and pragmatics. In the data we considered, this dissociation is shown to hold in acquisition as well as breakdown, and in the case of selective linguistic impairment as well as selective preservation of language. The principles which subserve grammar and the principles by which grammar is learned appear to be distinct from those underlying semantics and pragmatics and other cognitive systems. This finding refutes basic tenets of the social/interaction model and of cognitive models of language acquisition, but supports current linguistic models of the adult system in which each module of grammar is considered an autonomous system and grammar *in toto* is considered an autonomous faculty of mind. Our findings, then, provide direct evidence for the independence of grammar as a cognitive system and for the task-specificity of grammar acquisition.

4.2 Conclusions

Language is such an integral part of the mind that it is difficult to conceive of how or in what sense language or any part of it could be considered

an independent aspect of cognition. Two of the three major approaches to the study of language acquisition reflect this disposition. A child comes into the world an unlearned, per- (or pre-) locutionary being, and in the context of nurturing and interaction with others and with the environment becomes a knowing and intentionally communicative being. Language development reflects *that* this is happening and sometimes *what* seems to be happening as well. And in the final outcome, the intelligent behaviour of a mature human being is complex, multidimensional, and reflective of a complex and interdependent network of knowledge. This fact has made it difficult and inherently 'unreasonable' for many whose goal is ultimately to develop a unified theory of mind or behaviour to consider language apart from the larger context in which it is embedded. To such scholars, a unified theory of mind will of necessity embody general principles – general learning principles, general organizing principles, and general principles governing behaviour. To scientists holding such assumptions, the integrated nature of development and mature behaviour is testimony to the correctness of this basic position. *Ergo*, development and behaviour should be examined as they are – embedded in a multidimensional mould.

To others, however, the complexity of human behaviour and intelligence would appear to defy their being based on only general principles. To these scientists, each area of intelligence and behaviour must be examined individually, then the principles found to underlie them compared and if possible, conflated. In an attempt to do this, ways must be found to examine the domain in question on its own.

It seems to me that by attempting to isolate and then examine a particular domain, both basic positions are tested; for only by examining each domain deeply enough to discover the abstract principles underlying it can these principles then be compared across domains.

To elucidate the potential separability of language, we have attempted to present data which would help illustrate whether and in what ways language is tied to other abilities and thus can perhaps be explained on the basis of these other abilities. We focused in particular on data relevant to the assertions of the three major approaches – that language is communicatively based, that language is tied to nonlinguistic cognitive abilities, that language is not tied to these other systems.

What we found first of all is that language is not 'all of a piece'. Some aspects of language do not appear separable from other domains. Lexical and propositional semantics appear yoked to conceptual and intellectual ability. Pragmatic aspects of language appear linked in part to social knowledge and in part to intellectual function. In contrast, however, grammar was shown to be dissociable from other knowledge domains both in acquisition and in degeneration. Grammar can be selectively impaired, and it can be selectively preserved. To this extent it can be said to be an independent cognitive system, based on domain-specific

structural principles, learned by a task-specific learning mechanism. Grammar is not explained or acquired by reference to other systems of knowledge or by reference to the larger context in which it is embedded. This finding will, I hope, contribute, not just to our understanding of language, but to the larger quest to understand the nature of the human mind.

Notes

1 Significant portions of this paper were published elsewhere and as the reader will note, are much out of date. Important and exciting advances have been made in almost all areas covered since this paper was written, in particular, the state of the art with respect to theories of language development, normal and disordered. They are too numerous to discuss or even reference herein, however.

2 The case name 'Marta' is no longer being used. 'Laura', her real name, is now being used.

References

Anderson, J. (1977), 'Induction of augmented transition networks', *Cognitive Science*, 1, 125–57.

Annett, M. (1973), 'Laterality of childhood hemiplegia and the growth of speech and intelligence', *Cortex*, 9, 4–33.

Archibald, Y., J. Wepman and L. Jones (1967), 'Nonverbal cognitive performance in aphasic and nonaphasic brain-damaged patients', *Cortex*, 3, 275–94.

Bartak, L., M. Rutter and A. Cox (1975), 'A comparative study of infantile autism and specific developmental receptive language disorder: I The children', *British Journal of Psychiatry*, 126, 127–48.

Basser, L. S. (1962), 'Hemiplegia of early onset and the faculty of speech with special reference to the effects of hemispherectomy: two case studies', *Brain*, 85, 427–60.

Bates, E. (1976) *Language and Context: the Acquisition of Pragmatics*, New York; Academic Press.

— (1979), *The Emergence of Symbols*, New York: Academic Press.

Bates, E., L. Benigni, I. Bretherton, L. Camaioni and V. Volterra (1977), 'From gesture to the first word: on cognitive and social prerequisites', in M. Lewis and L. Rosenblum (eds), *Interaction, Conversation and the Development of Language*, New York: John Wiley.

Bayles, K. (1979), 'Communicative profiles in a geriatric population', unpublished PhD dissertation, University of Arizona.

— (1982), 'Language function in senile dementia', *Brain and Language*, 16 (2), 265–80.

Bayles, K. and C. K. Tomoeda (1983), 'Confrontation naming impairment in dementia', *Brain and Language*, 19, 98–114.

Beilin, H. (1975), *Studies in the Cognitive Basis of Language Development*, New York: Academic Press.

Benson, D. F. and N. Geschwind (1972), 'Aphasia and related disturbances', in A. Baker (ed.), *Clinical Neurology*, New York: Harper & Row.

Benton, A. (1965), 'Developmental aphasia and brain damage', *Cortex*, 1, 40–52.
Bishop, N. (1967), 'Speech in the hemiplegic child', in *Proceedings of the 8th medical and educational conference of the Australian cerebral palsy association*, Melbourne, Victoria: Tooranga Press, 141–53.
Blank, M., M. Gessner and A. Esposito (1979), 'Language without communication: a case study', *Journal of Child Language*, 6, 329–52.
Bradley, D. C. (1978), 'Computational distinctions of vocabulary type', unpublished PhD dissertation, MIT.
Bresnan, J. (1978), 'A realistic transformational grammar', in M. Halle, J. Bresnan and G. Miller (eds), *Linguistic Theory and Psychological Reality*, Cambridge, Mass.: MIT Press.
Brown, J. (1977), *Mind, Brain, and Consciousness: The Neuropsychology of Cognition*, New York: Academic Press.
Bruner, J. (1975), 'The ontogenesis of speech acts', *Journal of Child Language*, 2, 1–19.
Caramazza, A. and R. Berndt (1978), 'Semantic and syntactic processes in aphasia: a review of the literature', *Psychological Bulletin*, 85 (4), 898–918.
Case, R. (1978), 'Intellectual development from birth to adulthood: a neo-Piagetian interpretation', in R. Siegler (ed.), *Children's Thinking: What Develops?*, Hillsdale, N.J.: Lawrence Erlbaum.
Chomsky, N. (1965), *Aspects of the Theory of Syntax*, Cambridge, Mass.: MIT Press.
— (1975), *Reflections on Language*, New York: Random House.
— (1976), 'On the biological basis of language capacities', in R. Reiber (ed.), *The Neuropsychology of Language*, New York: Plenum Press.
— (1980a), 'On cognitive structures and their development: a reply to Piaget', in M. Piattelli-Palmarini (ed.), *Language and Learning: The Debate between Jean Piaget and Noam Chomsky*, Cambridge, Mass.: Harvard University Press.
— (1980b), 'On binding', *Linguistic Inquiry*, 11, 1–46.
— (1980c), *Rules and Representations* New York: Columbia University Press.
— (1981), *Lectures on Government and Binding: The Pisa Lectures*, Dordrecht: Foris.
Compton, A. (1970), 'Generative studies of children's phonological disorders', *Journal of Speech and Hearing Disorders*, 35, 315–39.
Corrigan, R. (1978), 'Language development as related to stage 6 object permanence development', *Journal of Child Language*, 5, 173–90.
— (1979), 'Cognitive correlates of language: differential criteria yield differential results', *Child Development* 50, 617–31.
Cross, T. (1977), 'Mothers' speech adjustments the contributions of selected child listener variables', in C. Snow and C. Ferguson (eds), *Talking to Children*, Cambridge: Cambridge University Press.
Cummings, J., F. Benson and S. LoVerme (1980), 'Reversible dementia: illustrative cases, definition and review', *Journal of the American Medical Association*, 243 (23), 22434–9.
Curtiss, S. (1977), *Genie: A Psycholinguistic Study of a Modern-day 'Wild Child'*, New York: Academic Press.
— (1979), 'Genie: language and cognition', *UCLA Working Papers in Cognitive Linguistics*, 1, 15–62.
— (1981a), 'Dissociations between language and cognition', *Journal of Autism and Developmental Disorders*, 11, 15–30.
— (1981b), 'Language and the brain', paper presented at the Society of Research in Child Development biennial meeting, Boston, Mass.

— (1982), Developmental dissociations of language and cognition', in L. Obler and L. Menn (eds), *Exceptional Language and Linguistics*, New York: Academic Press.
— (1985), 'The development of human cerebral lateralization', in D. F. Benson and E. Zaidel (eds), *The Dual Brain*, New York: Guillford.
Curtiss, S., V. Fromkin and S. Krashen (1978), 'Language development in the mature (minor) right hemisphere', *ITL: Journal of Applied Linguistics*, 39–40, 23–7.
Curtiss. S., V. Fromkin, S. Krashen, D. Rigler and M. Rigler (1974), 'The linguistic development of Genie', *Language*, 50, 528–54.
Curtiss, S., D. Kempler and J. Yamada (1981), 'The relationship between language and cognition in development: theoretical framework and research design', *UCLA Working Papers in Cognitive Linguistics*, 3, 1–59.
Curtiss, S., D. Kempler and A. LaRue (1981), 'Language and cognition in dementia: a case study', *UCLA Working Papers in Cognitive Linguistics*, 3, 161–75.
Curtiss, S. and J. Yamada (1981), 'Selectively intact grammatical development in a retarded child', *UCLA Working Papers in Cognitive Linguistics*, 3, 61–91.
Curtiss, S., J. Yamada and V. Fromkin (1979), 'How independent is language? On the question of formal parallels between grammar and action', *UCLA Working Papers in Cognitive Linguistics*, 1, 131–57.
Daumer, G. (1832), *Mittheilungen über Kaspar Hauser*. Nuremberg.
de Ajuriaguerra, J., A. Jaeggi, F. Guinard, F. Kocher, M. Maquard, S. Roth and E. Schmid (1976), 'The development and prognosis of dysphasia in children', in D. Morehead and A. Morehead (eds), *Normal and Deficient Child Language*, Baltimore: University Park Press.
Dennis, M. (1980a), 'Language acquisition in a single hemisphere: semantic organization', in D. Caplan (ed.), *Biological Studies of Mental Processes*, Cambridge, Mass.: MIT Press.
— (1980b), 'Capacity and strategy for syntactic comprehension after left or right hemidecortication', *Brain and Language*, 10, 287–317.
Dennis, M. and B. Kohn (1975), 'Comprehension of syntax in infantile hemiplegics after cerebral hemidecortication: left hemisphere superiority', *Brain and Language*, 2, 475–86.
Dennis, M. and H. Whitaker (1976), 'Language acquisition following hemidecortication: linguistic superiority of the left over the right hemisphere', *Brain and Language*, 3, 404–33.
— (1977), 'Hemispheric equipotentiality and language acquisition', in S. Segalowitz and F. Gruber (eds), *Language Development and Neurological Theory*, New York: Academic Press.
Dore, J. (1978), 'Variations in preschool children's conversational performances', in K. Nelson (ed.), *Children's Language*, vol. 1, New York: Gardner Press.
Edwards, M. and B. Bernhardt (1973), 'Phonological analysis of the speech of four children with language disorders', unpublished ms.
Eisenson, J. (1972), *Aphasia in Children*, London: Harper & Row.
Elliott, D. and R. Needleman (1981), 'Language, cognition and pragmatics: the view from developmental disorders of language', *UCLA Working Papers in Cognitive Linguistics*, 3, 199–207.
Ferreiro, E. (1971), *Les Relations temporelles dans le langage de l'enfant*, Geneva: Droz.
Fodor, J. (1983), *The Modularity of Mind: An Essay on Faculty Psychology*, Cambridge, Mass.: MIT Press.

Freedman, P. and R. Carpenter (1976), 'Semantic relations used by normal and language-impaired children at stage I', *Journal of Speech and Hearing Research*, 19, 785–95.
Fromkin, V., S. Krashen, S. Curtiss, D. Rigler and M. Rigler (1974), 'The development of language in Genie: a case of language acquisition beyond the "critical period" ', *Brain and Language*, 1, 81–107.
Furth, H. (1964), 'Sequence learning in aphasic and deaf children', *Journal of Speech and Hearing Disorders*, 29, 171–7.
Furth, H. and P. Puffall (1966), 'Visual and auditory sequence learning in hearing-impaired children', *Journal of Speech and Hearing Research*, 21, 118–35.
Gallagher, T. and B. Darnton (1978), 'Conversational aspects of the speech of language disordered children: revision behaviors', *Journal of Speech and Hearing Research*, 21, 118–35.
Glass, A., M. Gazzaniga and D. Premack (1973), 'Artificial language training in global aphasics', *Neuropsychologia*, 11, 95–103.
Gleitman, L., E. Newport and H. Gleitman (1982), 'The current status of the motherese hypothesis', unpublished ms.
Gleitman, L. and E. Wanner (1982), 'Language acquisition: the state of the state of the art', in E. Wanner and L. Gleitman (eds), *Language Acquisition: The State of the Art*, New York: Cambridge University Press.
Gold, E. (1967), 'Language identification in the limit', *Information and Control*, 10, 447–74.
Goldstein, K. (1948), *Language and Language Disturbances*, New York: Grune & Stratton.
Goodglass, H. and E. Baker (1976), 'Semantic field, naming and auditory comprehension in aphasia', *Brain and Language*, 3, 359–74.
Goodman, J. (1972), 'A case study of an autistic savant: mental function in the psychotic child with markedly discrepant abilities', *Journal of Child Psychology and Psychiatry*, 13, 267–78.
Greenfield, P. (1978), 'Structural parallels between language and action in development', in A. Lock (ed.), *Action, Symbol and Gesture: The Emergence of Language*, London: Academic Press.
Greenfield, P. and L. Schneider (1977), 'Building a tree structure: the development of hierarchical complexity and interrupted strategies in children's constructive activity', *Developmental Psychology*, 13, 299–313.
Greenfield, P., K. Nelson and F. Saltzman (1972), 'The development of rulebound strategies for manipulating seriated cups: a parallel between action and grammar', *Cognitive Psychology*, 3, 291–310.
Grice, H. (1975), 'Logic and conversation', in I. D. Davidson and G. Harmon (eds), *The Logic of Grammar*, Encino, Calif.: Dickerson Press.
Hamsher, K. (1981), 'Intelligence and aphasia', in M. Sarno (ed.), *Acquired Aphasia*, New York: Academic Press.
Head, H. (1926), *Aphasia and Kindred Disorders of Speech*, Cambridge: Cambridge University Press.
Hećaen, H. and M. Albert (1978), *Human Neuropsychology*, New York: John Wiley.
Heilman, K., and E. Valenstein (1979), *Clinical Neuropsychology*, New York: Oxford University Press.
Heyer, K. (1964), *Kaspar Hauser und das Schicksal Mitteleuropas im 19. Jahrhundert*, Stuttgart: Verlag Freies Geistesleben.
Hood, P. and M. Perlstein (1955), 'Infantile spastic hemiplegia, II: Laterality of involvement', *American Journal of Physical Medicine*, 34, 457–66.

Howes, D. (1967), 'Some experimental investigations of language in aphasia', in K. Salzinger and S. Salzinger (eds), *Research in Verbal Behaviour and Some Neurophysiological Implications*, New York: Academic Press.
Hyams, N. (1983), 'The acquisition of parameterized grammars', unpublished PhD dissertation, CUNY.
Ingram, D. (1975), 'If and when transformations are acquired by children', in D. Dato (ed.), *Developmental Psycholinguistics: Theory and Applications*, Washington, DC: Georgetown University Press.
— (1976), *Phonological Disability in Children* New York: Elsevier.
— (1978), 'Sensori-motor intelligence and language development', in A. Lock (ed.), *Action, Gesture and Symbol: The Emergence of Language*, New York: Academic Press.
Inhelder, B. (1963), 'Observations sur les aspects operatifs et figuratifs de la pensée chez des enfants dysphasiques', *Problèmes de Psycholinguistique*, 16, 143–53.
— (1966), 'Cognitive development and its contribution to the diagnosis of some phenomena of mental deficiency', *Merrill-Palmer Quarterly*, 12, 299–319.
Inhelder, B., I. Lezine, H. Sinclair and M. Stambak (1972), 'Les debuts de la fonction symbolique', *Archives Psychologiques*, 41, 187.
Irigaray, L. (1973), *Le Langage des dements*, The Hague: Mouton.
Johnston, J. and A. Kamhi (1982), 'The same can be less: syntactic and semantic utterances of language-impaired children', unpublished ms.
Johnston, J. and V. Ramstad (1978), 'Cognitive development in pre-adolescent language impaired children', in M. Burns and J. Andrews (eds), *Selected Papers in Language and Phonology*, Evanston, Ill.: Institute for Continuing Professional Education.
Johnston, J. and T. Schery (1976), 'The use of grammatical morphemes by children with communication disorders', in D. Morehead and A. Morehead (eds), *Normal and Deviant Child Language*, Baltimore: University Park Press.
Johnston, J. and S. Weismer (1983), 'Mental rotation abilities in language disordered children' *Journal of Speech and Hearing Research*, 26, 397–403.
Kamhi, A. (1981a), 'Developmental as difference theories of mental retardation: a new look', *American Journal of Mental Deficiency*, 86, 1–7.
— (1981b), 'Nonlinguistic symbolic and conceptual abilities of language-impaired and normally developing children', *Journal of Speech and Hearing Research*, 24, 446–53.
Kamhi, A., H. W. Catts, L. Koenig and B. Lewis (1984), 'Hypothesis testing and nonlinguistic symbolic abilities in language impaired children', *Journal of Speech and Hearing Disorders*, 49 (2), 169–76.
Kanner, L. (1943), 'Autistic disturbances of affective contact', *Nerv. Child*, 2, 217–50.
Kean, M. (1977), 'The linguistic interpretation of aphasic syndromes: agrammatism in Broca's aphasia, an example', *Cognition*, 5, 9–46.
Keenan, E. O. and B. Schieffelin (1976), 'Topic as a discourse notion: a study of topic in the conversations of children and adults', in C. Li (ed.), *Subject and Topic*, New York: Academic Press.
Kempler, D. (1984), 'Syntactic and symbolic abilities in Alzheimer's disease', unpublished Phd dissertation, UCLA.
Kempler, D. and S. Curtiss (1982), 'The changing neuropsychological profile of Turner's syndrome', unpublished ms.
— (1983), 'Selective preservation of syntax in Alzheimer's patients', paper

presented at the 8th Annual Boston University Conference on Language Development.
Kessler, C. (1975), Post-semantic processes in delayed child language related to first and second language learning', in Dato (ed.), *Georgetown University Roundtable on Language and Linguistics*, Washington, DC: Georgetown University Press.
Kimura, D. (1967), 'Functional asymmetry of the brain in dichotic listening', *Cortex*, 3, 166–78.
Klein, S. (1981), 'Syntactic theory and the developing grammar: re-establishing the relationship between linguistic theory and data from language acquisition', unpublished PhD dissertation, UCLA.
Kussmaul, A. (1884), *Les Troubles de la parole*, trans. A. Rueff, Paris: Bailliere.
Leonard, L. (1972), 'What is deviant language?', *Journal of Speech and Hearing Research*, 27, 427–46.
— (1979), 'Language impairment in children', *Merrill-Palmer Quarterly*, 25 (3), 205–32.
— (1982), 'Phonological deficits in children with developmental language impairment', *Brain and Language*, 16 (1), 73–86.
Levelt, W. (1975), 'What became of LAD?', *Peter de Ridder Publications in Cognition*, I, Lisse, The Netherlands: Peter de Ridder Press.
Lhermitte, F., J. Derousne and A. Lecours (1971), 'Contribution à l'étude des troubles semantique dans l'aphasie', *Révue Neurologique*, 125, 81–101.
Lichtheim, L. (1885), 'Über aphasie', *Deutsche Arch. kin. Med.*, 36, 204.
Lorentz, J. (1974), 'A deviant phonological system of English', *Papers and Reports on Child Language Development*, 8, 55–64.
Lovell, K., H. Hoyle and M. Siddall (1968), 'A study of some aspects of the play and language of young children with delayed speech', *Journal of Child Psychology and Psychiatry*, 9, 41–50.
MacNamara, J. (1972), 'The cognitive basis of language learning in infants', *Psychological Review*, 79, 1–13.
— (1977), 'From sign to language', in J. Macnamara (ed.), *Language Learning and Thought*, New York: Academic Press.
McAdam, D. and H. Whitaker (1971), 'Language production: electroencephalographic localization in the normal human brain', *Science*, 172, 499–502.
McFie, J., and M. Piercy (1952), 'The relation of laterality of lesion to performance on Weigl's sorting test', *Journal of Mental Science*, 98, 299–305.
Miller, J., R. Chapman and J. Bedrosian (1977), 'Defining developmentally disabled subjects for research: the relationships between etiology, cognitive development and language and communicative performance', paper presented at the Second Annual Boston University Conference on Language Development, October 1977.
Money, J. (1964), 'Two cytogenic syndromes: psychologic comparisons, I. Intelligence and specific-factor quotients', *Journal of Psychiatric Research*, 2, 223–31.
Morehead, D. (1972), 'Early grammatical and semantic relations: some implications for a general representational deficit in linguistically deviant children', *Papers and Reports on Child Language Development*, 4–12.
Morehead, D. and D. Ingram (1973), 'The development of base syntax in normal and linguistically deviant children', *Journal of Speech and Hearing Research*, 4, 1–12.
Nelson, K. (1977), 'Facilitating children's syntax acquisition', *Developmental Psychology*, 13, 101–7.
Newport, E. (1982), 'Task specificity in language learning? Evidence from speech perception and American Sign Language', in E. Wanner and L. Gleitman (eds), *Language Acquisition: The State of the Art*, New York: Cambridge University Press.
Newport, E., L. Gleitman and H. Gleitman (1977), 'Mother I'd rather do it myself: some effects and non-effects of motherese', in C. Snow and C. Ferguson (eds), *Talking to Children*, Cambridge: Cambridge University Press.
Newson, J. (1978), 'Dialogue and development', in A. Lock (ed.), *Action, Gesture and Symbol: The Emergence of Language*, New York: Academic Press.
Nicolich, L. (1977), 'Beyond sensorimotor intelligence: assessment of symbolic maturity through analysis of pretend play', *Merrill-Palmer Quarterly*, 23, 89–99.
Nichols, M., L. Obler and M. Albert (1982), 'Lexical access in healthy aging and in Alzheimer's dementia', paper presented at the Boston University Conference on Language Development.
Piaget, J. (1962), *Play, Dreams, and Imitation in Childhood*, New York: W. W. Norton.
— (1980), 'Schemes of action and language learning', in M. Piattelli-Palmarini (ed.), *Language and Learning: The Debate between Jean Piaget and Noam Chomsky*, Cambridge, Mass.: Harvard University Press.
Pies, H. (1966), *Kaspar Hauser, eine Dokumentation*, Ansbach: Brueghel.
Pietler-Ley (1927), *Kaspar Hauser Bibliographie*, Ansbach: Brueghel.
Pinker, S. (1979), 'Formal models of language learning', *Cognition*, 7, 217–83.
— (1984), *Language Learnability and Language Development*, Cambridge, Mass.: Harvard University Press.
Rankin, J., D. Aram and S. Horwitz (1980), 'A comparison of right and left hemiplegic children's language ability', paper presented at the annual meeting of the International Neuropsychological Society.
Ratner, N. B. and C. Pye (1984), 'Higher pitch in babytalk is not universal: acoustic evidence from Quiche Mayan'. *Journal of Child Language*.
Rees, N. S. (1973), 'Auditory processing factors in language disorders: the view from Procrustes' bed', *Journal of Speech and Hearing Disorders*, 38, 304–15.
Roeper, T. (1972), 'Approaches to a theory of language acquisition', unpublished PhD, dissertation, Harvard University.
— (1982), 'The role of universals in the acquisition of gerunds', in E. Wanner and L. Gleitman (eds), *Language Acquisition: The State of the Art*, New York: Cambridge University Press.
Saxman, J. and J. Miller (1973), 'Short term memory and language skills in articulation-deficient children', *Journal of Speech and Hearing Research*, 16, 721–30.
Schiefflin, B. and E. Ochs (1983), 'A cultural perspective on the transition from prelinguistic to linguistic communication', in R. M. Golinkoff (ed.), *The Transition from Prelinguistic to Linguistic Communication*, Hillsdale, N.J.: Lawrence Erlbaum, 115–31.
Schiff, N. (1979), 'The influence of deviant maternal input on the development of language during the preschool years', *Journal of Speech and Hearing Research*, 22, 581–603.
Schwartz, M., O. Marin and E. Saffran (1979), 'Dissociations of language function in dementia: a case study', *Brain and Language*, 7, 277–306.
Shaffer, J. (1962), 'A specific cognitive deficit observed in gonadal aplasia (Turner's syndrome)', *Journal of Clinical Psychology*, 18, 403–6.
Shankweiler, D. and M. Studdert-Kennedy (1967), 'Identification of consonants and vowels presented to left and right ears', *Quarterly Journal of Experimental Psychology*, 19, 53–63.

Shatz, M. (1977), 'The relationship between cognitive processes and the development of communication skills', *Current Theory in Motivation* Series, 25, 1–42.
— (1982), 'On mechanisms of language acquisition: can features of the communicative environment account for development?', in L. Gleitman and E. Wanner (eds), *Language Acquisition: The State of the Art*, New York: Cambridge University Press.
Silbert, A., P. Wolff and J. Lilienthal (1977), 'Spatial and temporal processing in patients with Turner's syndrome', *Behavioral Genetics*, 7, 11–21.
Sinclair, H. and E. Ferreiro (1970), 'Compréhension, production, et répétition des phrases à mode passif', *Archives Psychologiques*, 40, 1–42.
Snow, C. (1972), 'Mother's speech to children learning language', *Child Development* 43, 549–65.
— (1977), 'Mother's speech research: from input to interaction', in C. Snow and C. Ferguson (eds), *Talking to Children*, Cambridge: Cambridge University Press.
Snow, C. and C. Ferguson (1977), *Talking to Children: Language Input and Acquisition*, Cambridge: Cambridge University Press.
Snyder, L. (1976), 'The early presuppositions and performatives of normal and language disabled children', *Papers and Reports on Child Language Development*, 12, 221–9.
Spinnler, H., and L. Vignolo (1966), 'Impaired recognition of meaningful sounds in aphasia', *Cortex*, 2, 337–48.
Stark, R. (1967), 'A comparison of the performance of aphasic children on three sequencing tests', *Journal of Communication Disorders*, 1, 31–4.
Stark, R. and P. Tallal (1979), 'Analysis of stop-consonant production errors in dysphasic children', *Journal of the Acoustical Society of America*, 66, 1703–12.
Tallal, P. and M. Piercy (1973), 'Defects of non-verbal auditory perception in children with developmental aphasia', *Nature*, 241, 468–9.
— (1975), 'Developmental aphasia: the perception of brief vowels and extended stop consonants', *Neuropsychologia* 13, 69–74.
Tallal, P., R. Stark and B. Curtiss (1976), 'Relation between speech perceptual impairments and speech production impairments in children with developmental aphasia', *Brain and Language*, 3, 305–17.
Tallal, P., R. Stark, C. Kallman and D. Mellits (1979a), 'Perceptual constancy for phonemic categories: a developmental study with normal and language impaired children', unpublished ms.
— (1979b), 'Developmental dysphasia: the relation between acoustic processing deficits and verbal processing', unpublished ms.
— (1981), 'A re-examination of some non-verbal perceptual abilities of language-impaired and normal children as a function of age and sensory modality', *Journal of Speech and Hearing Research*.
Varney, N. (1980), 'Sound recognition in relation to oral comprehension and reading comprehension in aphasic patients', *Journal of Neurology, Neurosurgery, and Psychiatry*, 43, 71–5.
Veneziano, E. (1981), 'Early language and nonverbal representation: a reassessment', *Journal of Child Language*, 8, 541–63.
von Feuerbach, A. (1832), *Example of a Crime on the Intellectual Life of Man*, Ansbach.
Warrington, E. (1975), 'The selective impairment of semantic memory', *Quarterly Journal of Experimental Psychology*, 27, 635–57.
Weiner, P. (1974), 'A language-delayed child at adolescence', *Journal of Speech and Hearing Disorders*, 39, 202–12.

Wexler, K. (1977), 'Transformational grammars are learnable from data of degree 2, *Social Sciences Working Papers*, no. 129, School of Social Sciences, University of California, Irvine.
— (1982), 'A principle theory for language acquisition', in E. Wanner and L. Gleitman (eds), *Language Acquisition: The State of the Art*, New York: Cambridge University Press.
Wexler, K. and P. Culicover (1980), *Formal Principles of Language Acquisition*, Cambridge, Mass.: MIT Press.
Whitaker, H. (1976), 'A case study of isolation of the language function', in H. Whitaker and H. A. Whitaker (eds), *Studies in Neurolinguistics*, vol. 2, New York: Academic Press.
Wood, C., W. Goff and R. Day (1971), 'Auditory evoked potentials during speech perception', *Science*, 173, 1248–51.
Yamada, J. (1981), 'Evidence for the independence of language and cognition: a case study of a "hyperlinguistic" adolescent', *UCLA Working Papers in Cognitive Linguistics*, 3, 121–60.
— (1983), 'The independence of language: a case study', unpublished PhD dissertation, University of California, Los Angeles.
Yamada, J. and S. Curtiss (1981), 'The relation between language and cognition in a case of Turner's syndrome', *UCLA Working Papers in Cognitive Linguistics*, 3, 93–115.
Zaidel, E. (1973), 'Linguistic competence and related functions in the right cerebral hemisphere of man following commissurotomy and hemispherectomy', unpublished PhD dissertation, California Institute of Technology.
— (1974), 'Language, dichotic listening, and the disconnected hemispheres', paper presented at the conference on Human Brain Function, UCLA, September 1974.
Zangwill, O. (1964), 'Intelligence in aphasia', in A.V.S. de Reuck and M. O'Connor (eds), *Disorders of Language*, Boston: Little, Brown.
— (1969), 'Intellectual status in aphasia'. in P. J. Vinken and G. Bryun (eds), *Handbook of Clinical Neurology*, Volume 4: *Disorders of Speech, Perception and Symbolic Behavior*, Amsterdam: North-Holland.
Zukow, P., J. Reilly and P. Greenfield (1979) 'Making the absent present: facilitating the transition from sensorimotor to linguistic communication', in K. Nelson (ed.), *Children's Language*, Vol. 3, New York: Gardner Press.