Tutorial overview

Language breakdown and linguistic theory:
A tutorial overview

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Abstract

This tutorial discusses the theoretical and empirical framework and the potentially controversial assumptions within which research into language breakdown is being conducted. The focus is on questions that bear upon the relevance of studies of language pathology to linguistic theory. Issues concerning meta-theory are considered along with specific predictions related to acquired pathologies, specifically agrammatism, as well as to developmental language deficits, specifically, SLI, as well as research into a selective sample of other congenital disorders. We discuss issues such as the interpretation of Fodorian modularity, syndromes vs. case studies and brain plasticity, along with questions related to patients’ diagnosis and the clinical and theoretical validity of syndromes. Review and discussion of specific hypotheses are restricted to the computational parts of language – syntax and morphology – excluding all other topics. The final section is a summary and a discussion of the current state of affairs with respect to linguistic studies of language breakdown. © 1999 Elsevier Science B.V. All rights reserved

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1. Introduction

The study of language breakdown can be looked at from two different perspectives: that of understanding the pathology and that of learning about the normal process. While there is a significant overlap between these perspectives, the two con-
cerns are not the same, particularly since they advocate different methodologies. The field of neuropsychology has not been careful about distinguishing the two, not even when it assumed the name of Cognitive Neuropsychology. Questions related to patients' diagnosis, the clinical and theoretical validity of syndromes and the characterization of lesion sites in the brain have not been kept separate from issues related to the empirical confirmations of specific theoretical predictions that concern normal cognition. While in the first type of studies patients selection and the homogeneity of diagnosis are of crucial importance, in the second type the medical diagnosis is of little concern since there is no attempt to describe the nature of a syndrome. In principle, one good subject may be enough to illustrate a theoretical point related to normal cognition, provided the appropriate data are collected. These methodological issues have been debated in the literature and will be reviewed below.

What is meant by language breakdown? Acquired language breakdown is typically observed in people who suffered brain damage due to some physical event. It is assumed that these patients had normal language and were of normal intelligence prior to the incident and have 'acquired' the deficit as a result of their illness. Ideally, one would want to find patients with a selective impairment, that is, patients in whom language is impaired, yet the rest of cognition is intact. Such cases would allow one to attribute the behavior to a breakdown of the linguistic faculty rather than to other factors which may interact with it. The specific definition of what constitutes 'selective impairment' changes with the theoretical framework one espouses. It may relate to the language faculty as a whole, to levels of analysis, such as syntax or the lexicon, or to specific systems within levels. Unfortunately, brain damage typically affects more than one function and thus 'clean' cases are rarely seen in the clinic.

A second type of population that has interested researchers consists of children and adults who have never had normal linguistic functioning, that is, individuals in whom the observed language deficits are congenital. In this population too, the inclusion of individuals who have other cognitive deficits besides the linguistic ones threatens to render the language data uninterpretable. Thus, the ideal population for linguistically oriented research includes children with specific language impairments (SLI), in whom hearing and non-verbal intelligence are within the normal range. However, the study of these children, as well as the study of individuals with congenital retardation, requires prior consideration of the issue of brain plasticity, as discussed below.

Typically, much of the linguistically oriented research into language disorders offers a characterization of language deficits in terms of damage to underlying structures. In all of those studies the damaged 'pieces' have been interpreted as pieces of the grammar. Ideally, such explanations would make 'all or none' claims – either the patients are good or they are bad at some construction. In practice, this is hardly ever the case, for patients' performance often varies across tasks and even across testing situations. Alternative approaches offer analyses in terms of processing load which generally involve non-linguistic capacities such as attention and speed. Such explanations are crucially concerned with frequency effects of the stimuli and with patients' inconsistent performance across tasks (but see Rapp and Caramazza, 1993,
for a different view). This tutorial will review structural as well as processing accounts of language breakdown.

Generally speaking, linguistic research into language breakdown raises two types of questions: meta-theoretical questions and specific predictions. By meta-theoretical questions we mean questions concerning the relevance of the familiar linguistic levels of analysis – e.g. morphology, syntax, semantics – to patients' performance, the status of words vis-à-vis morphemes or the separability of form and function. Such questions relate to the fundamental concepts of linguistic theories in general, although they are not completely divorced of more specific theoretical orientations. By specific predictions we mean issues that arise within a given theoretical framework and are interpretable only within a specific theory, for example, the analysis of the DP, evidence for the Binding principles or questions concerning the structure of the lexicon.

The central meta-theoretical question that has been looming behind these discussions is the issue of the modularity of language (Fodor, 1983). The view of cognition as modular, at least in some loose sense of the term, has been the accepted framework in adult neuropsychology. It is likewise frequently invoked, though by no means generally accepted in developmental studies. Linguistic theories of the generative persuasion presuppose modularity rather than argue for it, while criticisms of the generative approach often center around arguments against the modularity of language. The literature has not been very clear, however, on the exact meaning of modularity, nor has there been a clear idea on what constitutes empirical support for it. Below, we discuss the issue of modularity in the context of adult studies as well as with respect to development.

Our purpose in writing this tutorial was manifold. Given that the study of language breakdown is a joint enterprise of experimental neuropsychology and theoretical linguistics, it seems necessary to discuss in some detail the theoretical and empirical framework and the potentially controversial assumptions within which research into language breakdown is being conducted. Thus, a relatively large part of the paper is devoted to a discussion of issues such as modularity, syndromes vs. case studies, and brain plasticity. Another purpose was to review the major lines of research into acquired pathologies (i.e. agrammatism) and into developmental language deficits. It is not often that findings from these two separate fields of study are presented side by side. Such an overview may contribute to a clarification of the methodological issues that are relevant to both domains and perhaps enhance a dialogue between these currently little related areas of research. However, the discussion has been restricted to the computational parts of language – syntax and morphology – excluding all other topics. Given the amount of work in the field, a separate tutorial should be devoted to neuropsychological studies of the lexicon.¹

The paper is organized in the following way: section 2 discusses the theoretical and the empirical stance of the modularity thesis and the kind of data relevant to this thesis. Next we present a discussion of the methodological issues related to studies

¹ Similarly, this tutorial will not be concerned with disorders of reading and writing although there has been extensive research into these areas.
of agrammatism, with specific emphasis on issues concerning the selection of patients and the debate surrounding the single case vs. group studies. The fourth section reviews the main findings from patients with agrammatism that are relevant to linguistic theorizing. Section five discusses developmental studies. It lays out the general developmental hypotheses and the central methodological concerns, and discusses the issue of brain plasticity. Recent research with children with SLI, as well as research into a selective sample of other congenital disorders is reviewed. The final section is a summary and a discussion of the current state of affairs with respect to linguistic studies of language breakdown.

2. Modularity

2.1. What is Modularity?

Fodor's (1983) Modularity thesis has been among the most controversial, as well as the most productive proposals, in cognitive psychology in the last fifteen years. According to Fodor (1983), modules are input systems, whereas the more interactive cognitive processes, those concerned with the fixation of beliefs about the world, are referred to as 'central'. Fodorian modularity is an empirical claim and as such it sets a research agenda that centers around a list of properties whose co-occurrence defines modules. The relevant properties are the following: domain specificity, mandatoriness and speed of operations, informational encapsulation, autonomy of computation, lack of access by other systems to intermediate levels of representations, shallow output, neural localization and susceptibility to characteristic breakdown. Fodor's prime examples of modules are language comprehension and visual perception. It has been noted by many (e.g., Moscovitch and Umilta, 1990) that not all these properties are critical to the same extent for the distinction between central processes and modules. For example, properties such as speed of operation, neural localization and susceptibility to characteristic breakdown may be found in central processes as well as in input systems. Similar to other discussions in the literature, the exposition here will focus on domain-specificity and informational encapsulation because these are the properties most unique to modules.

Consider the notion of 'domain-specificity': one of the sources of the difficulty in fully evaluating the state of the art in the debate surrounding Modularity is the confusion in the ways the terms 'domain' and 'module' are used. Moscovitch and Umilta (1990) argue that in the absence of a generalized theory of cognitive domains, a loose way of using the notion of domains cannot be avoided and specific domains cannot be unambiguously delineated. Thus, the notion of a domain as it is used in cognitive studies is pre-theoretical and refers to a certain functional unity observed in behavior. The units that one chooses to refer to as constituting a domain may be large or small, and may be affected by familiar divisions into knowledge areas, natural domains,
physical phenomena and the like. In the present discussion we will distinguish between 'big' Modularity (spelled with capital 'M'), which is the Modularity of the domain of Language, or minimally, that of Grammar, and 'small' modularity (spelled with small 'm'), which refers to the internal, modular organization of the grammar.

The second crucial feature of Fodorian modules is informational encapsulation, i.e. the resistance of modules to top-down information, their impenetrability to general knowledge or to input from other modules. Informational encapsulation presupposes domain-specificity and thus, in the absence of a theoretical definition of a domain, encapsulation too cannot be theoretically well-defined. Arguments in favor of encapsulation are often of an intuitive nature.

2.2. Is language modular?

Does the insistence on input systems as the paradigmatic cases of Modularity necessarily mean that language production is non-modular (Higginbotham, 1987)? This discussion is particularly relevant in view of the focus on agrammatism, which involves a deficit in production as well as in comprehension. Clearly, if the defining characteristics of modularity include all the features listed by Fodor in his 1983 monograph (see our section 2.1), then language production must be thought of as non-modular. Yet, there may be other possibilities. For example, although categories and rules with which the grammar operates may be specifically linguistic, they may partially overlap with other domains, particularly the semantic-conceptual, e.g., the overlap that exists between grammatical categories, such as subject, and semantic ones, such as agent. Alternatively, there may be intermediate levels of representations feeding into other domains, or requiring information other than linguistic for working out meanings, e.g. the determination of pronominal and anaphoric reference. If one posits domain-specificity, but allows certain processes involved in production to be non-encapsulated, then Modularity of language in all its complexity may be a possibility worth investigating (Bock and Kroch, 1989).

Discussions of the Modularity of syntax and the work of the parser typically bring to the fore problems concerning notions of reference and logical scope. Can those be made sense of independently of semantic considerations? According to Chomsky (1986a), when notions such as reference and scope are used internally, in the study of mental representations, they are syntactic. Scope and reference become semantic when they are given an extra-mental interpretation. In other words, Chomsky (1986a) advocates a distinction between elements of the linguistic system, which by definition, are mental representations, and their interpretations, which have to do with the outside world. However, the meaning of this distinction is not clear in the case of abstract concepts, since, although they have to do with extra-mental reality, their interpretation is crucially dependent upon internal properties of the linguistic system (MacNamara, 1989).

It seems that if one adopts Chomsky's aforementioned distinction between syntax and non-syntax, that is, if the distinction is between symbol-symbol relation and symbol world relation, without distinguishing the types of symbols that go into the symbol-symbol systems, one is left with a division between syntax and pragmatics
and essentially without a well-defined domain of semantics. The theoretical gains from such a position have yet to be made clear. In the context of the present discussion, extending the notion of syntax to include what has hitherto been referred to as the semantics of linguistic entities obscures the idea of informational encapsulation and further removes linguistic models from a basic psychological intuition, namely, that one cannot conceive of comprehension and production of language as independent of meaning, i.e. of symbol-world relations.

2.3. Modularity, development and the brain

What exactly is being claimed about the brain when Modularity is invoked? The expectation that functions will be localized (Fodor, 1983) suggests that modularity is seen as a fixed structural property of the brain. It follows from such a view that in cases of well-defined localized insults to the brain there will be a characteristic breakdown. However, there are other ways in which Modularity may be instantiated. For example, it may be the product of a distributed net, yet in such a way that it will be obligatorily triggered by the relevant input; or it may be an operational option available to the mind if circumstances favor it. In other words, Modularity may be a processing option that the mind can select. It may be construed as a description of the ways in which the mind may analyze perceptual input and possibly also compute output, when speed and automaticity are required. Such an option may be task-specific or modality-specific, or it may even arise as a consequence of some unique situation for which this mode of operation may be optimal. In this case neural specificity which is one of the defining characteristics of Fodorian modules, may imply a capacity for reorganization which is specific to certain neural strata and not present in others. The view of Modularity as an option for reorganization, when specific conditions hold, suggests that diffuse damage may also incur what may appear to be domain-specific deficits, particularly in automatic, potentially 'modular' systems. For example, there may be cases in which the capacity for a modular mode of operation will be damaged while non-modular ways of execution will be preserved.

As it stands, the Modularity thesis makes no claim with regard to the development of language. Yet, clearly, if the developmental course exhibits modular properties from its inception, the plausibility of Modularity is enhanced. Consider the case of the development of grammatical categories: if one can show that linguistic rules require domain-specific categories as input, and that in the language of young children, syntactic categories are independent of pre-existing cognitive or social-communicative categories, then this is support for modularity. However, an informationally encapsulated developmental course is not a logical necessity, for it is still possible that there will be an interactive, non-modular developmental course which will result in a system that will ultimately be ‘bootstrapped’ into modularity. Proposals of this sort are Schlesinger’s (1982) 'semantic assimilation' model and Karmiloff-Smith’s model of the modularization of cognition (1992).³

³ However, Schlesinger (1982, 1988) argues that the adult grammatical categories, although formal, maintain a semantic flavor which attest to their origin, and account, in part, for category membership.
2.4. Internal modularity

The notion of internal modularity is immediately interpretable within the theory of Government and Binding (GB: Chomsky, 1986b). Potential candidates for the modules of grammar within GB framework are Theta-theory, Case theory, Control, Binding, the Empty Category principle and X'-theory. Similarly, in Generalized Phrase Structure Grammars (GPSG, Gazdar et al., 1985) a distinction is made between the level of phrase-structure configuration and the level of control of grammatical features, where the crucial notion is the Control-Agreement Principle (CAP). In GPSG, CAP and phrase-structure rules constitute different modules. Thus, in both GB and GPSG the theory offers potential candidates for internal modularity.

A different perspective is offered by Optimality Theory (OT; Archangeli, 1997). In OT each constraint, or rather each family of constraints, can be viewed as an independent entity with its own internal structure. However, there is a single constraint hierarchy which internally ranks all constraints with respect to their potential for violations. This hierarchy does not respect traditional levels of linguistic organization. Rather, it predicts interactions between phonological, syntactic or semantic constraints. OT thus contrasts sharply with the notion of internal modularity, offering a way of refuting the ensuing predictions.

In most of the data from brain damaged patients as well as the data from acquisition reviewed below, discussions revolve around specific predictions arising within particular grammatical models. Thus, while these studies are relevant to internal modularity, the findings can only indirectly address 'big' Modularity.

3. Issues of methodology

3.1. General assumptions

Underlying all work in cognitive neuropsychology is the axiomatic assumption that the highly specific patterns of dysfunction seen following brain damage reflect the structure of the intact cognitive system. There are two assumptions here: (a) The Fractionation assumption – that brain damage does not cause chaos to the system; rather, it damages it in predictable ways, i.e. along the lines of its basic organization and (b) The Transparency assumption – that individuals’ performance is transparent, so that one can hypothesize about the underlying mechanism from observation of patients’ behavior (Caramazza, 1984; McCloskey and Caramazza, 1988).

The Fractionation hypothesis is, in fact, in line with Grodzinsky’s (1986) constraint of breakdown-compatibility which requires that the predictions a theory makes should be compatible with breakdown patterns. It follows that the hypothesized structure of a domain dictates which patterns of impairment are possible and which are impossible. Thus, while there is no requirement that the complete profile of the behavior of an individual be accounted for, there is the requirement that predicted patterns will NOT be found.
From a developmental perspective the Fractionation hypothesis is problematic. The possibility that a congenitally deficient brain may be organized along different lines than the intact brain is not implausible, given the notion of brain plasticity and the potential for reorganization early in life, discussed in section 5. In practice, however, studies of various language disorders repeatedly show that although the ultimate achievements are often below those of normal children, the developmental course observed under pathology typically resembles the normal process (Levy et al., submitted; Leonard, 1997). Whereas delay is the hallmark of pathology, there is rarely actual deviance (but see Goad and Rabellati, 1994). Given the nature of the data from pathology, if one intends to argue about normal cognition from cases of congenital brain deficits, the rule has to be that only data which mirror normal development count as evidence. Cases in which there is deviance, although interesting in their own right, must remain at this point theoretically uninterpretable.

3.2. The non-relevance of syndromes

Two different notions of a syndrome can be defined: a strong notion and a weak one. In its strong sense a syndrome presents a way of grouping individuals in terms of specific sets of categories or processing components delineated by the normal mechanism. It is the modified structure that is found in the cognitive system as a result of brain damage, which determines the essence of the syndrome. It follows that success in characterizing a syndrome is dependent upon the degree of specificity with which the normal faculty and its potential modification can be described (Badecker and Caramazza, 1985). Practice in neuropsychology over the past decades has shown that syndromes are invariably heterogeneous in some critical ways. Thus, what begins as a specific syndrome said to have damaged a unitary cognitive module, in time fractionates into sub-syndromes which implicate more than the originally thought-of module (Shallice, 1979).

In its weak sense, a syndrome need not have a coherent interpretation in terms of the underlying cognitive structure or processing. Rather, it is based on the statistical reliability of the co-occurrence of symptoms, and there is no requirement that the functional organization of the cognitive system be respected. Clearly, in this weak sense the notion of syndrome is irrelevant to cognitive neuropsychology in general, and to neurolinguistics in particular. In this weak sense syndromes can nevertheless serve clinical purposes. They may be clinically significant in the diagnosis of patients and may predict treatment outcome. Furthermore, syndromes may have relevance to neurological studies provided they are informative with respect to physical proximity of functional areas in the brain. Notice, however, that theoretically at least, modules that are distinct at one level of description — the cognitive level — may be non-proximal and intermingled in their physical realization. Thus, a one-to-one mapping between the cognitive and the anatomical cannot be taken for granted. It follows that the issue of whether local damage to well-defined brain areas selectively impairs specific cognitive functions is critical in the mapping of brain areas to cognitive functions.
Part of the problem in interpreting the data from pathology seems to be that, although investigators have no reason to attempt syndromic generalizations, it is often the case that statements concerning syndromes – e.g. agrammatism or SLI – are nevertheless made. Thus, the literature, to be reviewed in the next sections, is utterly confusing with respect to the centrality of syndromes. Criticisms of given accounts often claim that the proposed accounts do not capture the entire data set, namely, that there are many more aspects to patients’ performance than the theory purports to explain. Whereas the latter complaint is legitimate coming from those interested in characterizing patients, it is of no concern to linguists interested in pathology for the sake of validating theories of normal functioning.

Summarizing, the notion of a syndrome carries no potential for theoretical insights in the domain of normal cognition, whereas it can serve to arouse unjustified controversies. From a psycholinguistic point of view all that matters are symptom patterns and the ways they map onto psycholinguistic theories (Ellis, 1987). Yet, syndromes continue to occupy the stage in research on language breakdown. It is as if the field of cognitive neurolinguistics cannot divorce itself from the use of these convenient, venerable terms, perhaps because of its close association with the medical world in which syndromes play such a crucial role.

3.3. Single-case studies

The single-case methodology presents a rationale which is in line with the anti-syndromic approach. In an influential series of papers, Caramazza and colleagues (Badecker and Caramazza, 1985; Caramazza, 1986; McCloskey and Caramazza, 1988) led the debate concerning the single-case vs. group studies in neuropsychology. Their claim was a very strong one: not only are single case-studies justifiable, but they are the only source of valid inferences about the structure of normal cognitive systems.

It is argued that the basic research activity involves determining for any patient whether there is an appropriate modification of a cognitive system, a ‘functional lesion’ in the authors’ terms, which would account for the observed pattern of performance. Averaging over patients involves the assumption that patients have identical functional lesions. However, determining what the functional lesion is requires that there be an analysis of patients’ performance over the relevant, theoretically delineated domains. In other words, testing patients in order to determine classification does not differ in any principled way from testing them for the specific questions that are under investigation. Thus, there is no a-priori way in which homogeneity can be established.

The key term in this approach is that of a ‘functional lesion’ – damage to particular components of a special cognitive architecture. It is only via a comprehensive analysis of a single patient’s performance in the relevant domain that the nature of

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4 Grodzinsky’s plea (1991) for the relevance of agrammatism to linguistic theorizing is confusing. While there may indeed be a group of patients in whom one can find a specific, theoretically motivated, linguistic deficit, and these patients typically are among those referred to as agrammatics, it is also quite clear that this group does not exhaust the clinical syndrome of agrammatism.
such a lesion may be determined. The fact that the findings may not be generalizable to other patients is unimportant since the research is not aimed at a characterization of brain-damaged patients in any general sense. The preferred methodology for reducing the probability of chance will not call for averaging over patients; rather, it will require multiple single-case studies.

Notice that if it had not been for its affinity with experimental psychology, the need to justify the advantages of the single-case method over group studies in research in language breakdown might not have arisen. Since modern linguistic theorizing hardly ever requires experimentation, the problem was never at the center of concern for linguists. Psycholinguistics, however, strives to retain the standards set by experimental work in other psychological domains and is therefore concerned with issues of patient selection and statistical validity which require particular attention when clinical populations are studied.

3.4. Design and analysis

In a review article in a special issue on Agrammatism (Brain and Language 50, 1995), Mauner criticizes the statistical validity of many of the reported findings, particularly with respect to the reliability of the measures of the patients’ sensitivity to grammatical constructions. She further analyzes the procedures for normalizing data and argues against some of the statistical interactions reported by some of the authors, when those were actually tested by statistically appropriate tests.

Caplan (1995) spells out further concerns about the validity of the findings. He points out problems in the construction of materials for testing patients, issues related to inadequate matching of controls with experimental subjects, a tendency to assert the most restrictive analysis of a patient’s performance when in fact a more general analysis may co-exist and the lack of appropriate control studies to rule out alternative explanations. These are major concerns which, in view of the acceptable standards in experimental cognitive science, could render the reported findings extremely problematic. The message from these critiques is clear: experimental research has no value unless it is methodologically sound.

In the next two sections we present an overview of recent research on acquired and developmental language pathology that bear upon linguistic theory.

4. Agrammatism

4.1. What is agrammatism?

A single type of acquired language impairment – agrammatism – has attracted the most attention from those interested in the relationship between language

5 Caplan (1995) is particularly concerned with the need to match agrammatic patients with patients who have a different diagnosis in order to control for what might be a non-specific effect of a neurological syndrome.
deficits and linguistic theory. Agrammatism was the name given at the beginning of the century to a pattern of language production that appeared to lack grammatical structure (Pick, 1913, quoted in Grodzinsky, 1990). This clinically defined behavioral pattern was typically associated with damage to Broca’s area. Agrammatic patients speak effortfully using a telegraphic style, often omitting (or substituting) grammatical morphemes and function words, while still using content words rather appropriately (DeBleser and Bayer, 1988; Goodglass, 1976). It has been known for quite some time, that the agrammatic production impairment frequently co-occurs with comprehension impairments (Caramazza and Zurif, 1976). While there is good performance on comprehension of simple actives and subject-gap relative clauses, agrammatics show poor performance on reversible passives and object-gap relative clauses. For a while, agrammatism represented a catastrophic ‘syntactectomy’ (Caramazza and Zurif, 1976) and hence provided compelling evidence for syntax as a distinct information type. This view has been considerably modified through recent research.

Below, we present accounts of agrammatic language under two main headings: (1) structural accounts, which claim that agrammatic deficits are caused by damage to syntactic representations. For example, that there is an underrepresentation of syntactic traces (Grodzinsky, 1995a,b) or an underspecification of functional nodes (Hagiwara, 1995; Friedmann and Grodzinsky, 1997) or an inability to use the argument structure of specific verbs (Kegl, 1995); and (2) processing accounts, according to which agrammatic deficits are caused by limitation of processing capacity in the face of preserved representations. For example, the Mapping hypothesis (Linebarger et al., 1983; Linebarger, 1995) which purports to explain patients’ performance across tasks, specifically, their good performance on judgments of grammaticality (Linebarger et al., 1983).

4.2. Structural accounts of agrammatism

4.2.1. Comprehension deficits

4.2.1.1. The Trace Deletion Hypothesis (Grodzinsky, 1984; 1995a,b). Prominent among the structural accounts of agrammatic comprehension is Grodzinsky’s Trace Deletion Hypothesis (TDH), which was first formulated in Grodzinsky (1984) and

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6 Pick (1913, quoted in Grodzinsky, 1990) noticed that the production patterns of some Broca’s aphasics were aberrant from a grammatical point of view. He did not formulate a precise statement of the speech patterns seen in these patients but argued that they could not construct sentences although they seemed to know the intended meaning. He termed the phenomenon ‘agrammatism’.

7 The insistence on studying agrammatics, namely, patients with production as well as comprehension problems, rather than aphasic patients with comprehension problems and no documented production deficits is not necessarily justified given the kind of questions that linguists focus on. Caplan (1995), in fact, argues that the classic finding reported for agrammatics of impaired sentence-picture matching for semantically reversible sentences with noncanonical orders (Nespoulous et al., 1988) is not found in all agrammatic patients whereas it is present in non-agrammatic patients (Caplan and Hildebrandt, 1988). In other words, according to Caplan (1995), it is not the case that there is something unique in the kind of comprehension problems seen in agrammatic patients and thus, despite its claims, the literature is, in fact, “not about agrammatism” (Caplan, 1995).
later revised in Grodzinsky (1995a,b). The original TDH stated that traces of movement are deleted from s-structure in agrammatic representations and consequently theta-role assignment to moved constituents cannot take place. Moved NPs are assigned a theta-role through a default nonlinguistic strategy, on the basis of their linear position in the sentence. The proposed default strategy leads to representations which consist of two Agent thematic roles, one assigned grammatically, the other strategically. Such representations lead to chance performance on passives, object-gap relative clauses and object clefts. When the moved constituent is supposed to be the Agent (as in subject-gap relative clauses and subject clefts), no such competition occurs and agrammatic performance is intact.

Developments in linguistic theory and further data from patient studies led Grodzinsky (1995a) to reexamine the TDH. The VP-internal subject hypothesis states that subjects are always moved constituents and that the surface position of the subject is linked to the deep position which contains a trace. The representation of active and passive sentences, under the VP internal hypothesis, is:

(1) The lion, is \( t_i \) chasing the tiger.
(2) The lion, was \( t'_i \) chased \( t_i \) by the tiger.

In the active sentence there is one chain (the lion, \( t_i \)) which follows from the movement of the VP internal subject to its surface position. The theta-role of the moved NP can be easily inferred. In the passive sentence there is, likewise, a single chain (the lion, \( t'_i, t_i \)), but the subject has been moved twice: once from object position into Spec of VP, creating \( t_i \), and then from that position into its surface position at the beginning of the sentence, creating \( t'_i \).

Grodzinsky (1995a) suggests a restrictive version of the TDH which holds that trace deletion is applicable only to theta positions. Following findings by Hickok and Avrutin (1995), which showed that agrammatics perform differently on which questions (chance) vs. who questions (above chance), Grodzinsky adds that the nonlinguistic cognitive strategy which is part of the TDH should be restricted to referential expressions. The TDH is thus restated restrictively: only traces in theta positions are deleted while NPs lacking a theta-role receive one strategically (by their linear position) if and only if they are referential. For example, sentence (3a)

(3) a. The man, is \( t'_i \) desired \( t_i \) by the woman
   Theme                      Experiencer

undergoes trace deletion and becomes (3b):

   b. The man is * desired * by the woman
      *                            Experiencer

which, as a result of strategy application is interpreted, wrongly, as (3c):

   c. The man is * desired * by the woman
      Agent              Experiencer
Several authors proposed that the TDH should be based exclusively on structural aspects, and that assumptions about nonlinguistic strategies should be avoided. These proposals are based mainly on esthetic concerns, namely, the wish to restrict the theory to a specific type of arguments, i.e. structural arguments. For example, Hickok and Avrutin (1995) argue that Grodzinsky’s (1995a) default strategy is unnecessary. They argue that without VP-internal subjects, a chain disruption hypothesis does not differentiate subject-gap from object-gap sentences: both contain one chain. Assuming the VP-internal subject hypothesis, however, subject-gap sentences contain one chain and object-gap sentences contain two chains. Thus, given the VP-internal hypothesis, the thematic assignment representation for object-gap relative clauses is ambiguous, while that for subject-gap relative clauses is unambiguous, and hence the difference in performance. The default strategy is no longer needed and the account can be purely structural.

Grodzinsky (1995b) rejects this criticism and argues that a purely structural account cannot explain the fact that agrammatic performance varies on sentences with identical syntactic structures that differ in their thematic roles. An interaction between the strategy and the thematic grid is mandatory, according to this account.

Consider examples (4)–(6), including nonagentive predicates (4), psychological predicates (5), and agentive predicates (6):

(4)  a. The car blocks the truck.
    b. The truck is blocked by the car.

(5)  a. The woman despises the man.
    b. The man is despised by the woman.

(6)  a. The woman holds the man.
    b. The man is held by the woman.

According to the TDH, in agentive active sentences (like (6a)), an agentive role is strategically assigned to the first NP and the result matches the correct representation. In agentive passive sentences (like (6b)) an agentive role is assigned to two NPs – structurally to the one in the by-phrase (via by), and strategically to the first NP. The resulting representation creates a competition between two identical roles and thus guessing. In nonagentive sentences (like (4) and (5)), however, a nonagentive label is replaced with an agentive label and the competition is between non-identical thematic labels. In order to arrive at valid predictions, Grodzinsky uses Jackendoff’s (1972) Thematic Hierarchy which places thematic roles in the following hierarchical order: agent > experiencer > location, source, goal > theme, arguing that the passive by-phrase must be higher on the Thematic Hierarchy than the derived subject.

Following the VP internal subject hypothesis, all active sentences involve movement of the subject. If traces are deleted, subjects remain with no theta-roles and are strategically assigned an Agent role. When an Agent role is strategically assigned to a position which should receive an Agent role, as in (5), compensation leads to above chance performance. When an Agent role is strategically assigned to positions which should receive other roles (Instrument in (4) or Experiencer in (5)), the sub-
ject remains with a theta-role which is hierarchically higher than that of the object, and agrammatic performance is predicted to be above chance. In cases in which an Agent role cannot be assigned (e.g. to inanimate subjects, as in (4)), agrammatic patients will reinterpret the thematic representation and assign the subject the next role down the hierarchy. This process should lead to above chance performance on this sentence type.

Agrammatic performance on passives is similarly handled. The original TDH predicts chance performance on sentences such as (6b) and (4b), due to competition between two Agent roles and replacement according to the Thematic Hierarchy, respectively. In (5b) the resulting thematic representation would be subject=Agent, object=Experiencer, such that the NP in the by-phrase would be hierarchically lower, rather than higher, than the derived subject. This explains agrammatics' below chance performance in cases such as (5b).

4.2.1.2. The Theta-Assignment Principle (Hagiwara, 1993). While Grodzinsky's theory is well articulated, several authors find it lacking in critical aspects. Japanese presents a problem to accounts such as the Trace Deletion Hypothesis, since it has a sentence-final non-theta position NP, and it is difficult to decide what would be the default value of the theta-role in such a position. Looking at gapped and gapless passives in Japanese, Hagiwara (1993) argues that the Head initial/Head final parameter, the directionality parameter of theta-assignment, and the distinction between internal and external arguments are retained in agrammatic comprehension. She shows that agrammatics interpret sentences by the argument structure of the predicate and by the canonical direction of the theta-assignment. She further develops the principle proposed by Hagiwara and Caplan (1990) which says that when theta-assignment to the internal argument conforms to the directionality of theta-assignment in the normal grammar, and the adjacency condition governing this assignment is satisfied, performance is above-chance. When these conditions are not met, performance is at chance.

Hagiwara (1993) formulates the following principle for agrammatic theta-role assignment:

- Assign the internal argument of a [+V, -N] category first to the adjacent NP, according to the canonical direction of theta-role assignment in a given language, and then assign external argument to a non-theta-marked NP.
- Assign the external argument to the NP with the nominative case-marker, which is specified in the theta grid of the verb in question.

While the first statement is universal, the second is specific to Japanese. Hagiwara shows that this principle correctly accounts for agrammatic performance on a variety of Japanese constructions, including several types of passives as well as subject and object cleft constructions.

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8 Saddy (1995) argues that a different pattern of results is seen when sentences such as (4)–(6) contain quantifiers. An explanation of the pattern of results is offered in semantic terms, assuming that the agrammatic deficit lies in assigning a nominal interpretation to verbs.
4.2.1.3. The Double Dependency Hypothesis (Mauner et al., 1993). Mauner et al. (1993) attempt to account for agrammatic comprehension without resorting to the default strategy as proposed by Grodzinsky (1995a). Their motivation for attempting this goes beyond esthetics: since a compensatory heuristic is outside general principles of linguistic organization, it is unclear what constrains different individuals to formulate the same heuristic following brain damage.

Mauner et al. (1993) assume that agrammatics’ difficulties arise in the process of forming and interpreting syntactic chains. They further assume that syntax fails in constraining the process of semantic interpretation, although they identify the defect in the construction of the syntactic structure itself, rather than in the interpretative mechanisms. Thus, the Double Dependency Hypothesis assumes that the deficit underlying asyntactic comprehension affects the processing of syntactic referential dependencies. According to this account, traces are represented whenever they are required, yet the process of coindexation is deficient. When there is only one referential dependency, the resulting syntactic representation, although abnormal, is not ambiguous; when there are two such dependencies, the resulting representation is semantically ambiguous.

Under the VP-internal hypothesis, all sentences involve movement and agrammatics generate both correct and incorrect coindexations for all sentences. The deficit affects not only thematic dependencies between traces and moved NPs, but also non-thematic dependencies between pronouns and their antecedents. According to Mauner et al. (1993), the breakdown of the Coindexation Condition may account for the differential pattern of performance on grammaticality judgments reported by Linebarger et al. (1983). Since possible coindexations lead to ambiguity but not to ungrammaticality, incorrect coindexations impairing comprehension can be rejected in making grammaticality judgments.

4.2.2. Production deficits

While many studies describe agrammatic production, few attempt to provide linguistic explanations of the findings. We chose to present two new approaches which draw upon recent developments in linguistic theory, i.e. the hierarchical order of functional categories in the syntactic tree, and the representation of argument structures.

4.2.2.1. Hierarchical Breakdown of Functional Categories (Hagiwara, 1995; Friedmann and Grodzinsky, 1997). Traditional descriptions of agrammatic production assume that all functional morphemes are equally affected by the disorder (but see DeBleser and Luzzati, 1994). Hagiwara (1995) argues that this is not the case, but rather that elements appearing in lower positions in the structural hierarchy tend to be retained while those situated in higher positions tend to be omitted. Looking at Japanese, the immediate implications of this account are that Neg is more accessible than Tense and that Tense is more accessible than CP in Japanese clauses, while PP is more accessible than DP in Japanese noun phrases.

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9 DeBleser and Luzzati (1994) report findings from agrammatic Italian patients. Whereas agreement was correct in simple clauses, the patients failed on agreement in richer syntactic contexts.
Hagiwara (1995) analyzes data from several Japanese agrammatics and shows that none of the patients omit negatives and postpositions (lowest in the hierarchy) in required contexts. On the other hand, complementizers and case-markers are omitted quite frequently. Hagiwara (1995) also cites cross-linguistic evidence supporting her account, specifically Italian agrammatics' ability to place adverbs correctly around finite and non-finites verbs (Lonzi and Luzzati, 1993) and French agrammatics' intact negation (Nespoulous et al., 1990).

Hagiwara (1995) restates her account in line with Chomsky's (1993) Economy theory, arguing that the fewer number of times the operation Merge takes place, the more economical the resulting structures are and the more accessible they are to an agrammatic aphasic. The motivation for the ordering of categories is provided in terms of computational cost, since access to the lower projections is less costly than access to the higher projections.

Friedmann and Grodzinsky (1997) provide further evidence showing that agrammatic production does not manifest a total loss of functional categories. They report of a Hebrew-speaking patient who performs well on tasks involving gender and number agreement while her tense inflection is severely impaired. These results can be accommodated within the framework suggested by Pollock (1989) according to which tense and agreement form independent nodes on the syntactic tree. Given that the tense deficit is accompanied in this patient by impaired copula production, loss of the ability to embed sentences, and deficits in the use of complementizers and Wh-words, Friedmann and Grodzinsky (1997) argue that a syntactic account is necessary to best explain the complete picture.

Friedmann and Grodzinsky (1997) propose the Tree-Pruning hypothesis, stating that a defective node implicates all nodes above it (in this case the CP, hence the deficit in complementizers and Wh-words, in embedding and in Wh-questions). Consequently, an underspecified node cannot project any higher. Degrees of severity seen among patients may be accounted for in structural terms, such that the lower the impaired node, the more severe the deficit. The first assumption of the Tree-Pruning hypothesis is thus revised, namely, either C, T, or Agr is underspecified in agrammatic production.

Friedmann and Grodzinsky (1997) argue that once a distinction between tense and agreement is taken note of, there are several cases of French, Italian, and English-speaking agrammatics whose performance is similar to that of the Hebrew-speaking patient they discuss.

4.2.2.2. The Argument Structure Account (Kegl, 1995). Kegl (1995) uses the typology of argument structures as a guide in the analysis of agrammatic production. She defines argument structure patterns in terms of the d-structure subject (external argument), d-structure direct object (internal argument), or d-structure indirect object (indirect argument) that verbs select for. Kegl assumes that agrammatics have access to the lexical representations of verbs but lack access to syntactic movement rules that shift noun phrases to different argument positions. Her account is unique in that it provides predictions as to the constructions missing from agrammatic production.

Kegl argues that verbs whose argument structure contain an external argument are
easier for agrammatics, because they do not trigger movement rules that displace arguments from their lexically specified positions. Focusing on verbs that lack an external argument, Kegl shows that agrammatics’ production fails on constructions in which there is a mismatch between d-structure and s-structure. Such constructions include passives, unaccusative intransitives like *bloom* and *appear*, amuse-type psychological verbs, and subject-raising verbs like *seem*. Zero copular sentences in which, although an argument is moved, there is no explicit verb present, do not pose a problem because the order of arguments in s-structure resembles that of d-structure (s-structure *Mary is a doctor* vs. d-structure *e (is) Mary a doctor*).

4.3. Processing accounts

A major concern of processing accounts of agrammatism is the fact that agrammatic comprehension varies greatly across tasks, most notably in the case of grammaticality judgments which patients can make with respect to structures that they fail to produce or comprehend (Linebarger et al., 1983). Proponents of processing approaches argue that this fact is sufficient to warrant an explanation of agrammatic comprehension in terms of failure to use syntactic information rather than in terms of a structural-representational deficit. The relevance of these accounts to the perspective taken in this tutorial concerns the criticism they offer of structural accounts of agrammatism as well as the potential contributions of processing theories to models of the linguistic parser.

4.3.1. The Mapping Hypothesis (Linebarger et al., 1983; Linebarger, 1995)

The Mapping hypothesis offers an account of the fact that some agrammatics can judge the grammaticality of structures which they cannot comprehend (Linebarger et al., 1983). Linebarger (1995) argues that agrammatic comprehension arises not from a failure to compute syntactic structure but from a failure to exploit it. Of central importance are structures which prove difficult for agrammatics in both comprehension tests and grammaticality judgments. Those typically involve linkage of two positions. For example, thematic interpretation can be seen as a process of linking syntactic representations with theta grids. Under the Mapping hypothesis, theta assignment even for unmoved arguments is problematic, since it involves linking elements in the s-structure with their theta grids. The Mapping hypothesis predicts that syntactic movement complicates this linkage process, because dependencies between elements must be taken into account.

According to the Mapping hypothesis, extra-grammatical processes, which are also operative in normal processing, disrupt mapping to a different degree with regard to each of the affected structures. Linebarger (1995) lists three such extra-grammatical processes. The first is the effect of a fixed linear order among words. A common explanation for the difficulty posed by passives and object-gap relative clauses is that these structures violate canonical linear order of thematic roles and are thus less automatic and more impaired in agrammatism. The second facilitating extra-grammatical factor is the ‘nearest NP effect’. It has been observed that intervening NPs (i.e. NPs inside a relative clause situated between the matrix subject and
its verb) tend to lead to comprehension errors. The third extra-grammatical process is a selectionally-based role filling. Work on on-line semantic and pragmatic processing shows that subjects carry out initial thematic role assignments during parsing which then facilitate the syntax-based mapping. Incorrect semantic or pragmatic assignment may lead to degraded syntax-based mapping.

There could be several sources to this hypothesized mapping failure. It could be the case that agrammatics lose verb-specific thematic information, but then one must explain why there is a syntactic complexity effect. Also, if the problem were lexical, specific verbs would be more affected than others. The mapping failure could also be a result of a memory impairment. Linebarger (1995) notes that such impairments remain to be articulated in sufficiently compelling detail to be postulated as the source of the mapping failure.

4.3.2. The Computational Hypothesis (Friederici and Frazier, 1992)

Friederici and Frazier (1992) argue that the properties of agrammatic comprehension derive from a computational limitation. The complexity of the chain of inferences required for retrieving the correct grammatical structure accounts for agrammatics' failure to construct the right interpretation. The longer the chain, the poorer the agrammatic comprehension performance. Thus, Friederici and Frazier (1992) assume that the grammar is intact and that so is the thematic processor, but that input rate, memory span, and computational speed account for agrammatics' poor performance.

Friederici and Frazier's (1992) findings show no difference in performance on German sentences with an SVO word order as compared to an SOV order. Agrammatics can recover the surface structure of both orders correctly. However, processing limitations lead to poor performance when the task changes. Agrammatics do not delay theta-role assignment until all potential arguments have been encountered. Rather, the role of the external argument is assigned to a locally unmarked argument when that argument is first heard. In line with this proposal, agrammatics have more problems in assigning the correct theta-roles if the sentences precede the relevant test pictures, rather than if pictures are shown during sentence presentation. Friederici and Frazier suggest that agrammatics' impairment could be attributed to the loss of automaticity of syntactic parsing. In the absence of fast and automatic parsing procedures, task demands are more likely to affect processing. Furthermore, this loss seems to cause a high sensitivity to syntactic violations which explains why agrammatics do better on grammaticality judgments than on tests of comprehension.

4.3.3. The Time-Based Approach (Kolk, 1995)

Kolk (1995) argues that the processing failure seen in agrammatism may be the result of desynchronization. It is assumed that the elements needed to build a sentence representation have levels of activation which determine their availability.

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10 This observed variation in performance may be attributed to a decline in verbal memory, though the authors reject this criticism in light of the poor correlation between the experimental results and the memory measures collected from the same patients.
Once a critical level of activation has been reached, that element becomes available. Activation levels are then subject to decay. In addition, it is assumed that activation of elements is interdependent and activation of one element may be required for the activation of another. For example, information about the sentence subject must be activated in order for the right form of the verb to become activated.

Two accounts of possible time-based deficits are suggested. The Slow Activation account assumes that it takes longer for an element to reach its critical level of activation and thus this level is occasionally reached too late. The Fast Decay account assumes that elements become unavailable when they fall below their critical level too soon to be combined with other elements in the sentence representation. According to Kolk (1995), comprehension may require elements to be available for longer than the time needed by grammaticality judgments and therefore comprehension is disrupted by slow activation or by fast decay of syntactic information.

Data in support of Kolk’s time-based approach come from a variety of studies. For example, Haarmann and Kolk (1994) found that agrammatics showed an agreement effect only for simple (i.e. conjoined) sentences but not for complex (i.e. embedded) sentences. This finding was interpreted as evidence for impairment in the processing of complex structures, rather than impairment in the representation of specific structures. Furthermore, a delay between the presentation of the syntactic frame and the target NP abolished the agreement effect for agrammatics but not for normal controls. This finding led the authors to the conclusion that the decay of information in agrammatism is faster than normal and that agrammatics suffer from a limited parsing capacity.

4.4. Summary of studies of agrammatism

Prominent among the structural accounts offered in the literature for agrammatic deficits are the following:

(a) The Trace Deletion hypothesis (TDH; Grodzinsky, 1984; 1995a,b) states that traces of movement are deleted from s-structure in agrammatic representations and consequently theta-role assignment to moved constituents cannot take place. Moved NPs are assigned a theta-role through a default nonlinguistic strategy, on the basis of their linear position in the sentence. This deficit accounts for chance performance on passives, object-gap relative clauses and object clefts. Following findings by Hickok and Avrutin (1995), the nonlinguistic, cognitive strategy, which is part of the TDH, has been restricted to referential expressions.

(b) The Theta-Assignment principle (Hagiwara, 1993) argues that agrammatics interpret sentences by the argument structure of the predicate and by the canonical direction of the theta-assignment. It is predicted that when theta-assignment to the internal argument conforms to the directionality of theta-assignment in the normal grammar, and the adjacency condition governing this assignment is satisfied, performance will be above chance, but when these conditions are not met, performance will be at chance (Hagiwara and Caplan, 1990).

(c) The Double Dependency hypothesis (Mauner et al., 1993) assumes that agrammatics’ difficulties arise in the process of forming and evaluating syntactic
chains. Under the VP-internal hypothesis, all sentences involve movement and agrammatics may generate both correct and incorrect coindexations for all sentences. The deficit affects not only thematic dependencies between traces and moved NPs, but also non-thematic dependencies between pronouns and their antecedents.

(d) The Hierarchical Breakdown of Functional Categories (Hagiwara, 1995; Friedmann and Grodzinsky, 1997) states that a defective node implicates all nodes above it. Consequently, an underspecified node cannot project any higher. Degrees of severity seen among patients may be accounted for in structural terms such that the lower the impaired node, the more severe the deficit.

(e) The Argument Structure approach (Kegl, 1995) focuses on verbs that lack an external argument. Kegl (1995) shows that agrammatics’ production fails on constructions in which there is a mismatch between d-structure and s-structure, whereas zero copular sentences in which there is no explicit verb present, although an argument is moved, do not pose a problem. This is so because the order of arguments in s-structure resembles that of d-structure.

All the above proposals draw upon GB theory and consider the data from agrammatic patients as support for the existence of the specific structures that were tested. If indeed patients’ performance can be described in terms of these structural accounts, internal modularity, the modularity of specific parts within grammar, will be enhanced. However, the literature suggests a more complex picture.

Two types of criticisms have been raised against structural accounts of agrammatism. (1) with respect to any given task, agrammatic performance does not show complete loss of even the most specific structures and hence the whole notion of structural deficit or loss is problematic; and (2) there is considerable variability in patients’ performance across tasks. The most remarkable finding in this respect concerns patients’ good performance on grammaticality judgments which provides a counterexample to the selective loss of syntax. In general, it has been maintained that the current formulations of the structural accounts are not sufficiently stronger than accounts of agrammatism which resort to all-purpose comprehension strategies such as linear word order and the proximity of NP antecedents.

The following processing accounts have been reviewed:

(1) Linebarger (Linebarger et al. 1983; Linebarger, 1995) proposes the Mapping hypothesis which argues that agrammatic comprehension breakdown arises not from a failure to compute syntactic structure but from a failure to exploit it. The Mapping
hypothesis assumes that syntactic movement complicates the linkage of elements in
the s-structure with their theta grids because dependencies between elements must be
taken into account. Extra-grammatical processes, which are also operative in normal
processing, disrupt mapping to a different degree with regard to each of the affected
structures.

(2) Friederici and Frazier (1992) propose that the complexity of the chain of infer-
ences required for retrieving the correct grammatical structure accounts for agram-
matics' failure to construct the right interpretation. The longer the chain, the poorer
the agrammatic comprehension performance. Thus, it is assumed that the grammar is
intact and that so is the thematic processor, but that input rate, memory span and
computational speed account for agrammatic's poor performance.

(3) Kolk (1995) argues that the agrammatic processing failure may be the result of
desynchronization. Two accounts of possible time-based deficits are suggested. The
Slow Activation account assumes that it takes longer for an element to reach its critical
level of activation such that this level is occasionally reached too late. The Fast Decay
account assumes that elements become unavailable when they fall below their critical
level too soon to be combined with other elements in the sentence representation.

In sum, structural accounts of agrammatic deficits are very appealing. They are
well within the tradition of scientific theorizing – they espouse a detailed theoretical
model within which one can make specific predictions that are falsifiable. On the
other hand, processing accounts of patients’ deficits typically resort to non-linguistic
competencies – memory and on-line computation – and discuss issues such as atten-
tion overload and type of task. Yet, given the nature of linguistic performance and
the variability seen in patients’ behavior, considerations of processing cannot be eas-
ily dispensed with. Our taste for theoretical elegance may have to give way to more
psychologically realistic models that will combine linguistic insights with perfor-
ance factors.

Nevertheless, a caveat seems in order. Notice that all the above proposals, struc-
tural as well as processing models, deal with the syndrome of agrammatism. As
argued in the introduction, if one is interested in normal competence, syndromes
need not be looked at. It is likely that the picture would have been very different and
structural accounts would have gained in empirical credibility had the hypotheses
been phrased with respect to individual patients over multiple tasks, as advocated by
Caramazza and colleagues (Caramazza, 1984, 1986).

5. Developmental language disorders

5.1. Introduction

5.1.1. Populations

Disorders of language development, and especially delay in the onset of language,
accompany most of the cognitively related developmental pathologies. Conse-
sequently, normal language development is seen as a major predictor of neurological
intactness in children. While in many of the congenital neurological syndromes lan-
Language performance correlates with the child's performance in other cognitive domains, the populations which have been of particular interest to linguistic research concern children in whom there is a dissociation between language functions and other, non-verbal tasks. The expectation has been that individuals with these syndromes may be particularly relevant to the study of Modularity.

Four congenital syndromes have been clinically observed, in which there is dissociation between language performance and performance on other cognitive tasks. The most relevant to linguistic research are children with specific language impairment (SLI). These children do not show any neurological signs; they perform well on non-verbal tasks but achieve lower scores on language-related tasks. Three other syndromes involve retardation – the Cocktail Party syndrome (Cromer, 1991), the Savants (Smith and Tsimipli, 1995) and Williams syndrome (Bellugi et al., 1994). In general, children with these syndromes have verbal abilities which are better than expected on the basis of their performance on non-verbal tasks. In some cases linguistic performance appears exceptional.

Another group of children relevant to the study of Modularity consists of the linguistic isolates. These are children who grew up with no language input, the best studied cases being that of Genie (Curtiss, 1979) and of the deaf children studied by Goldin-Medeaw (Goldin-Meadow and Mylander, 1990) who developed private language during their early years of life.12

We chose to focus the current review on studies of SLI and on two of the congenitally retarded populations: the case of Christopher, the polyglot savant (Smith and Tsimipli, 1995) and the language of children with Williams Syndrome, since those have been at the focus of recent research. Notice, however, that the relevance of cases of congenital neurological conditions to theories of normal language is not immediately clear. This is so since the Fractionation hypothesis (McCloskey and Caramazza, 1988) cannot be maintained in cases of congenital brain deficits unless there is evidence for plasticity, discussed below, which will guarantee that development in the deficient brain progresses along normal lines.

5.1.2. The issue of brain plasticity

The term 'brain plasticity' refers to the capacity of the brain to diminish the effects of lesions through structural functional changes (cf. Bach, 1990). The clinical manifestations of neuronal plasticity are observed especially after prenatal, neonatal or early childhood cerebral damage. The issue of brain plasticity has often been tied to the maturational theory of brain lateralization and the equipotentiality of the brain hemispheres for language (Lenneberg, 1967; but see Woods (1984) for a review of the empirical evidence against the equipotentiality of the hemispheres for language). Theoretically, however, brain plasticity is independent of the issue of the origin and timing of brain lateralization for language, although empirical demonstrations of plasticity could enhance arguments against the equipotentiality of the hemispheres at birth, as is indeed argued for in the literature (Dennis, 1980).

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12 For a discussion of the relevance of data from linguistic isolates to issues concerning Modularity, see Levy (1996).
Researchers have not agreed on a functional interpretation of the plasticity thesis. The common understanding has been that plasticity may account for the final outcome, namely, the level of linguistic achievements which children with congenital left hemisphere deficits can reach (but see Dennis (1980) and the critique offered in Bishop (1988)). A different way of interpreting plasticity may be in relation to the normalcy or pathology in the developmental course traversed by children with brain abnormalities.

Despite the emphasis on the role of brain plasticity in behavior, recent work on developmental brain plasticity continues to focus on focal brain injuries. Thus, emphasis is on patients who have sustained unilateral cerebro-vascular insults at various periods in development (e.g. Chugani et al., 1996), whereas the application of the notion of brain plasticity to cases in which damage is diffuse is rarely attempted.

In view of the findings concerning language development in various neurological syndromes, Levy et al. (submitted) have recently suggested that the notion of plasticity be further extended to refer to congenital conditions which affect neurological status but are not focal. It is suggested that plasticity be thought of as a mechanism which guarantees the preservation of critical forms of cortical organization that serve the major cognitive domains, according to priorities which are functionally determined. Thus viewed, plasticity is orthogonal to questions concerning lateralization of functions, while the often-observed delay in development might be the cost paid for such extensive reorganizational work. If this view is accepted, the Fractionation hypothesis (Caramazza, 1986) can be extended to apply to developmental cases that do not involve focal lesions.

5.2. Specific Language Impairments (SLI)

5.2.1. What is SLI?

SLI is a clinically defined syndrome. Children with SLI show significant deficits in language ability but do not meet the criteria for other disability categories. In particular, children with SLI show normal hearing, age-appropriate scores on nonverbal tests of intelligence, no clear signs of neurological impairments, and none of the symptoms associated with autism. Being a clinically defined syndrome, SLI faces the same methodological concerns as do the acquired syndromes, e.g. agrammatism. The heterogeneity of the group remains considerable even when one restricts the discussions to grammatical SLI, that is, children who score below age level on grammar, excluding articulatory difficulties and lexical and pragmatic problems. Typically, clinicians describe children with SLI, particularly English-speaking children, as having outstanding difficulties with morphology. However, given that SLI is a universal phenomenon, and that English morphology is rather scarce, crosslinguistic studies are crucial.

In parallel to accounts of agrammatism, possible explanations for grammatical SLI fall into two broad categories: (1) accounts that relate to the underlying grammar in SLI and (2) processing accounts. Examples of the former are the Agreement Deficit account (Clahsen, 1989; Clahsen et al., 1997), the Implicit Rule Formation deficit (Gopnik, 1994) and the Extended Optional Infinitive stage (Rice and Wexler, 1996). An example of the latter is the Sparse Morphology account (Leonard, 1996).
5.2.2. Structural accounts of SLI

5.2.2.1. The Agreement Deficit Account (Clahsen, 1989; Clahsen et al., 1997). The Agreement Deficit account was originally formulated within the framework of GPSG (Gazdar et al., 1985). The notion of control within GPSG offers a way of formulating the distinction between functors and the categories controlling them. The claim is that features that enter into agreement relations and are controlled by some other element in the clause or the phrase are affected in SLI. In GPSG terms, the claim is that while the control-agreement principle is selectively impaired in SLI, configurational principles remain intact. Consequently, children with SLI should have no problem marking person on nouns, since person is an inherent property of nouns and no control is involved. Problems are expected with person and number features on verbs, which can be seen as controlled by the sentence subject.

In a later publication, Clahsen et al. (1997) formulate the Agreement Deficit account in terms of Chomsky’s (1995) non-interpretable and interpretable features. While the former have to be checked and deleted before LF, the latter contribute to the semantic interpretation of sentences. Within this system, the Agreement Deficit account might be restated in two ways: one possibility would be that non-interpretable features are affected. This would mean that SLI children have problems with case features, with movement and with phi-features and tense features of verbs. Alternatively, under a narrower view, just the optional non-interpretable phi-features of verbs, i.e. verb agreement features, would be affected (Clahsen et al., 1997: 47).

The predictions from the narrower assumption are that person and number inflection on verbs, yet not tense, ought to be severely impaired in SLI. It is expected that there will be dissociation between the feature content of subjects and that of verbs. SLI children should have their subject-DPs specified for NOM case and for phi-features even in sentences in which the agreement features of verbs are left unspecified. Verb raising, which is independent of the phi-features on verbs, should not be affected in SLI.

These predictions were investigated in English and German children who met the clinical definition of grammatical SLI. The relation between finiteness and case marking of subjects was investigated with respect to finite verb forms with overt tense/agreement inflections including modals and the suppletive be forms, and unflected verb forms (i.e. walk, take) which are ambiguous with respect to finiteness. There was a statistically significant difference between marking tense and marking person in English and a somewhat less clear advantage of preterites of main verbs in German over subject-verb agreement. The SLI children were similar to non-impaired controls with very few non-NOM subjects with finite verbs (i.e. him goes there), and significantly more non-NOM subjects with infinitivals (i.e. him drink).

In German nouns are marked for gender, number and person. Nominative, however, is the default case and therefore a strong test for case marking is excluded. According to the Agreement Deficit account, children with SLI are expected to show a dissociation between specification of phi-features on subjects, which are interpretable features relevant at I.F, and lack of non-interpretable phi-features on verbs. The findings from German SLI children suggest that in comparison to normal con-
trols these children produce fully specified subjects in root infinitive clauses rather often, while they also tend to err on finite verb forms with fully specified DP subjects. In other words, the expected dissociation between the two types of phi-features was found for German SLI children, supporting the Agreement Deficit account.

One consequence of the postulation of an agreement deficit is that children with SLI do not have a general paradigm of subject-verb agreement but a set of stored forms. Consequently, SLI children produce many non-finite forms. Since non-finite verbs appear in German in clause final position, it is expected that children with SLI will produce many verb final clauses. Indeed, the SLI data show that all the children have acquired the German V2 order. One child overextended this rule by raising non-finite verbs to second position, while another child underplayed it by having finite verbs in final position. Although such patterns are virtually missing from the control data, in all of the children with SLI most finite verbs appear in second position as indeed they should.\textsuperscript{13} These findings allowed Clahsen et al. (1997) to reject the hypothesis proposed by Grimm (1993) who argued that SLI involves genuine word-order deficits, and specifically problems with V2.

In sum, Clahsen et al. (1997) report poor scores on 3rd person -s in English and on various subject-verb agreement endings in German, as well as on extensive usage of bare stems. However, children with SLI perform much better on overt tense marking than on subject-verb agreement and their correctness scores for tense marking in English and for preterite in German are significantly higher than those for agreement. Furthermore, these children do not produce non-nominative subjects with finite verbs. This is expected to happen if tense is considered to control case assignment. German children with SLI use root infinitives with fully specified subjects. Some even raise non-finite verbs to V2 position – an error type which is completely absent from normal children’s usage. These errors suggest that the impairment is not simply that of bad timing but that there is deviance as well.

5.2.2.2. Familial SLI and the Implicit Rule Formation Deficit (Gopnik, 1994). Prominent among studies of SLI in the last decade has been the study of a single three-generational pedigree – the KE family – in which approximately half of the members have been diagnosed with language disorders. Although the research groups involved in the study of this family have not agreed on the characterization of the deficit – as detailed below – we have decided to include the KE family in the present review because of its uniqueness and the potential it offers for the study of the genetic basis of the disorder.

On the basis of data from the KE family, Gopnik and Crago (1991) put forth a hypothesis concerning the Missing Features deficit in SLI. The claim was that the disorder involves a deficit in IP, which results in an inability to mark grammatical features in underlying representations. A more recent statement of the theory (Gopnik, 1994) argues that children with SLI cannot reliably formulate implicit grammat-

\textsuperscript{13} Clahsen et al. (1997) suggest that V2 overappliers have a strong Comp which alone triggers verb raising: hence raising of non-finite verbs; V2 underappliers, on the other hand, may lack a strong C even when the verb is fully specified.
ical rules. In other words, according to this view, SLI is a deficit in grammar building. In the absence of implicit grammatical rules SLI children rely on conceptual rather than linguistic mechanisms to guide their usage of language. There are two types of compensatory mechanisms: SLI children may use rote memorized forms or they may apply explicit rules that have been taught to them. The evidence for this view comes from a set of studies of the KE family along with crosslinguistic evidence from Japanese, Greek and Inuktitut. Below, we summarize some of the findings related to the KE family that support the Implicit Rule Formation deficit:

In a study of grammatical number in SLI, Gillon and Gopnik (1994) argue that the impaired individuals do not have an intact underlying obligatory rule for grammatical number, though they are in command of the concepts of singularity and plurality. The patients' behavior was more akin to what is normally seen in the acquisition of irregular plurals than in the acquisition of regulars. In a series of tests the SLI subjects perform as if they had no rule for plural formation. Thus, they failed to generalize plural formation as well as to produce judgments of acceptability with respect to nonce words. The sometimes correct forms that they produced can be explained on the basis of cognitive compensatory strategies.

Goad and Rabellati (1994) argue that, similar to normal children, SLI children notice patterns once a certain threshold is reached. However, they still do not form a morphological rule but continue to work by analogy. Thus, stems and plurals are defined by the feature [+strident] in final position. The latter accounts for certain error patterns: sibilant-final real words often substitute for the plurals of phonetically similar nonce words; sibilants other than [s,z] may be used to form plurals and sibilant-final real words are often not overtly pluralized.

Dalalakis (1994) investigated the performance of subjects with familial SLI on adjectival comparative constructions. Subjects were tested on production and on rating of comparative adjectives. Subjects performed worse than both kindred normals and nonrelated controls in choosing and applying a comparative rule in every category they were tested on, and in rejecting bare stems or incorrectly marked forms as unnatural. It is concluded that the impairment seen in the subjects is a cross-category one in that it is similar to the impairment seen in the inflectional paradigms.

Ullman and Gopnik (1994) studied inflectional morphology in the KE family. Their findings suggest a deficit in tense formation in the affected members of the family yet not in the non-affected members. The impaired subjects' lack of regular morphological rule tense is supported by their failure to produce novel regulars and overregularizations, by the positive association between their success on regulars and past tense frequency, and by the lack of a positive association between their success on regulars and stem frequency.

Ullman and Gopnik (1994) offer two alternative hypotheses to explain the absence of the past tense rule: The Paradigm Formation Deficit hypothesis is based on ideas expressed by Pinker (1984) and Carstairs (1987) who associated every word with a matrix of its grammatically modified forms. These can be specified as individual lexical items (for irregulars) or as affixes (for regulars). If the paradigm itself is not properly formed, or if the mapping between root and affixes is not properly formed, neither stored nor computed forms are produced correctly.
The second hypothesis, the Feature Checking hypothesis, argues that if feature checking is impaired, errors of tense and agreement are to be expected. Notice, that the ultimate sentence will still have to meet conceptual requirements such as temporality, person or tense. Thus, a crucial part of the explanations advocated by Gopnik and colleagues hinges upon the existence of a conceptual system which is independent of, yet linked to, grammar, and is intact in these patients. This system can compensate to some degree for the deficits seen in the deficient morphological system.

In strong opposition to the analyses proposed by Gopnik and colleagues, Vargha-Khadem et al. (1995) argue that the affected members of the KE family are typically of borderline intelligence and their language impairment is not restricted to morphological features; rather, it concerns virtually every aspect of the grammar. Furthermore, members of this family have a severe orofacial dyspraxia, rendering their speech largely incomprehensible and therefore judgments concerning missing or wrong inflections are problematic.

The study of the KE family has been of central importance in the recent search for a genetic basis for grammar (Rice, 1996). The familial pattern of the impairment observed over three generations, is highly indicative of autosomal dominant inheritance (Pembrey, 1992; quoted in Gopnik, 1994). Recently, a region has been identified on chromosome 7 which co-segregates with the speech and language disorder and which in most likelihood, is the site for the responsible gene in this family (Fisher et al., 1998). Notice, however, that if the characterization of the KE family as given in Vargha-Khadem et al. (1995) is true, the KE family will not qualify as suffering from SLI.

5.2.2.3. Extended Optional Infinitives Stage (Rice and Wexler, 1996). Normal children go through a stage in which they produce nonfinite main clauses along with finite ones. This happens despite attested knowledge of tense and the possibility of verb movement and despite evidence for familiarity with conditions under which the verb raises and feature checking occurs. Wexler (1994) has termed this stage, reported in numerous languages, the Optional Infinitive Stage (OI) since, during the OI stage, children produce both types of verbs in main clauses, as if finiteness were optional.

In a number of publications, Rice and Wexler (1996; Rice et al., 1995) argue that if children with SLI adhere to the linguistic constraints that guide normal acquisition of morphosyntax – which is a necessary assumption if these data are to be taken as relevant at all (cf. the Fractionation hypothesis (Caramazza, 1986)) – then the expectation is that they too will show an OI stage. They will be distinguished, however, by (a) a later-than-expected emergence of the targeted grammatical forms (b) once finiteness emerges, a lower than expected use of finite forms where the adult grammar requires them and (c) a longer-than-expected period of OI, perhaps into adulthood. These phenomena are taking place in SLI during an Extended Optional Infinitive stage (EOI) and it is assumed that this is a developmental delay which can be outgrown.

A comparison of data from impaired and normal children indeed shows a lower than expected use of finite forms (-s, -ed, as well as inflected forms of be and do) by the impaired children. Whereas the SLI children omit the finite forms, they do not
assume that these forms can be applied in contexts not allowed in the adult grammar. These findings were interpreted as indication that the children with SLI know some important facts about English grammar. Specifically, the children's performance on be forms gives clear indication that they control agreement but are much less successful with tense.

Recent findings by Rice et al. (in press) for German and by Wexler et al. (submitted) for Dutch, confirm the existence of an OI stage in these languages and report findings with SLI children that are comparable to the findings in English concerning an EOI stage in SLI.

5.2.2.4. A Representational Deficit with Dependent Relationships (van der Lely, 1994; van der Lely and Stollwerck, 1997). Van der Lely and colleagues offer an account of grammatical SLI in terms of a modular language deficit involving dependent structural relationships between constituents. Thus, they argue for a Representational Deficit with Dependent Relationships (RDDR) in SLI. The relevant research is summarized below.

Van der Lely (1994) reports a significant difference between normally developing children and the children with SLI on tasks requiring 'reverse linking'. These are tasks in which children are shown novel events involving novel verbs along with their arguments, and are required to match the scene with a sentence of the right syntactic frame. Findings from children with SLI suggest that the assignment of thematic roles to objects does not correspond to the canonical linking between the thematic roles and the syntactic functions. Thus, SLI children knew something about syntactic frames involving a verb and two arguments, but they appeared unable to analyze the particular syntactic position and to reason back to the likely thematic roles.

A further investigation of the RDDR involved passives (van der Lely, 1996) and the potential differences between a verbal and an adjectival passive. The pattern of responses seen in grammatical SLI children indicates that they are sensitive to the morphological differences between active and passive forms of verbs as well as to the syntactic structure of active and passive sentences, although they perform significantly worse than the control group. With respect to passive constructions that are ambiguous between transitive and adjectival meaning, the SLI children show a strong preference for adjectival responses rather than for transitive responses, while the normally developing children produce a similar number of transitive and adjectival responses. Moreover, the SLI children allow an adjectival-stative interpretation for what should be syntactically unambiguous verbal passive sentences.

Van der Lely (1996) argues that the underlying syntactic representation derived by children with SLI is not sufficiently specified to rule out an adjectival-stative interpretation. The development of A-chains (Borer and Wexler, 1987) is required before a verbal passive may be unambiguously derived from sentences with a passive participle. A similar pattern characterizes, at least in some occasions, the comprehension patterns seen in young children. As for the relative success of children with SLI in comprehending full and progressive passives, reported in van der Lely (1996), this is achieved due to additional lexical information provided by the hy- phrase and the progressive ending on the auxiliary.
In a recent study of Binding theory in SLI, van der Lely and Stollwerck (1997) further investigated the predictions of the RDDR. The question concerned the intra-sentential assignment of reference to pronouns *(him, her)* and to anaphors *(himself, herself)*. The task involved conceptual-lexical and pragmatic knowledge (e.g. semantic gender, reflexive marking of the predicate and theta roles) and syntactic knowledge (Binding principles A and B). While SLI children perform well on sentences in which reference can be determined on the basis of lexical and pragmatic knowledge, they perform at chance when syntactic information is the sole determinant of appropriate and inappropriate reference. The authors conclude that SLI children lack the syntactic knowledge of the Binding principles.

Van der Lely and Stollwerck (1997) espouse the view of Giannelli and Manzini (1995) who argue that grammatical development is essentially growth in the ability to handle complex syntactic structures. Giannelli and Manzini (1995) propose that in the early stages of language acquisition the child’s grammar is restricted to ‘simple structures’ which correspond to local relations (in the sense of Chomsky, 1993), e.g. Head-Head, Head-Specifier, Head-Complement, whereas non-elementary dependencies, e.g. [D, agr, N] or [T, asp, V], develop later. With respect to SLI, van der Lely and Stollwerck (1997) argue that for all syntactic functions, such as movement, agreement and case assignment, involving relations within a local domain, the simpler the phrase-structure tree, the greater the possibility that any constituent within that tree will be realized correctly. Thus, case assignment, agreement, and theta role assignment are more likely to be realized correctly with intransitive verbs than with transitive verbs, which in turn may involve fewer errors than the more complex structures required for dative verbs. These predictions are borne out by the findings in van der Lely and Harris (1990) and van der Lely (1994).

Giannelli and Manzini’s (1995) ‘growth of grammatical complexity’ hypothesis, however, does not solve the problem of the inconsistencies that are so commonly seen in the grammars of children with SLI. All the data from SLI show that the children can and do produce most, if not all, morphological and syntactic forms. Yet, their grammar seems to lack the notion of the obligatoriness of such forms. The RDDR, as well as Giannelli and Manzini’s (1995) general framework cannot, in principle, account for this fact.

It seems to us that while the RDDR indeed describes an important set of data concerning SLI children’s difficulties in assigning theta roles to complex syntactic structures, the probabilistic nature of children’s performance argues against the conceptualization of SLI in such fixed structural terms. Approaches such as those of Leonard and colleagues (Leonard, 1992; 1996; Dromi et al., 1993; Leonard et al., 1992), detailed below, seem more promising in handling this issue.

5.2.3. Processing accounts of SLI

5.2.3.1. The Surface Hypothesis and the Sparse Morphology Hypothesis (Leonard, 1992, 1996). In opposition to the structural accounts of SLI, Leonard and colleagues have argued in numerous publications in favor of a processing-based approach to the deficits seen in SLI. Given that structural accounts are important in the context of
linguistic theorizing, there is an implicit critique of current grammatical models as well. Based originally on studies of English, the Surface hypothesis states that surface elements such as stress, frequency, obligatoriness and syllabic structure predict which morphological elements will be most frequently omitted in SLI. In view of data from other languages, a revised version of the Surface hypothesis, the Sparse Morphology hypothesis (Leonard, 1992, 1996), suggests that the limited processing resources of children with SLI are devoted to aspects of the language which are the most crucial and most informative in a given language.\footnote{The hypotheses proposed by Leonard (1992, 1996) are very similar to ideas expressed in Kean's (1977) seminal work on agrammatism.} It is argued that elements which are less frequent, are perceptually non-salient and non-redundant are acquired late by normal children and even later, or not at all, by children with SLI. In other words, SLI affects general processing mechanisms and thus elements in which breakdown is likely to be seen in normals under degraded conditions, will also be affected in SLI. Thus, the specific manifestations of SLI differ among languages, disclosing areas of vulnerability that may potentially collapse under natural, on-line processing load.

Consider the case of English: in English, nouns, verbs and adjectives appear as bare stems. Inflections are obligatory in relatively few linguistic contexts, they are unstressed and some take the form of word-final consonants. All these characteristics contribute to difficulties in processing and to late acquisition. It is predicted that English-speaking children with SLI will devote their limited resources to aspects of English that provide the most critical information – mainly word-order – with little left for morphology. On the other hand, in a language in which morphology carries a more central part of the information and is not sparse, morphological deficits will be less obvious (Leonard, 1992). In view of crosslinguistic evidence, the following conclusions are drawn: (1) the grammatical profiles of children with SLI vary according to the particular language which is being acquired; (2) even when some areas of the grammar lag atypically behind others, the general grammatical configuration is normal; and (3) the weak areas of grammar among children with SLI may be those that are most vulnerable to breakdown under degraded learning or processing conditions. Below we summarize the data cited in support of these conclusions.

The different patterns of deficit found in a comparative study of Italian, English and Hebrew children with SLI (Dromi et al., 1993; Leonard et al., 1992) indeed support the conclusion that the use of morphology is a function of the type of language acquired. The data from English are consistent with the expected picture, showing lower percentages of obligatory morphological features in children with SLI than in language-matched controls.\footnote{Two groups of controls are typically used in investigations of SLI: aged-matched and language-matched. Language matching is based on mean utterance length (MLU).} These group differences were seen when percentages were computed across all freestanding, closed-class morphemes (e.g. prepositions, articles) as well as across all grammatical inflections.

Unlike the English-speaking children, the Italian SLI children did not appear to have the same difficulty relative to MLU-matched controls with respect to grammatical
ical inflections. However, the SLI children had a significantly lower percentage of freestanding articles in obligatory contexts than the normal controls. Statistical analysis revealed, however, that both groups of Italian-speaking children showed greater use of singular articles than of plurals and wider use of more common forms than of articles with restricted phonetic environments.

The data from Hebrew speaking children with SLI reveal a pattern similar to that found in Italian. Inflections are used in similar percentages to the percentages seen in the MLU-matched controls, whereas the freestanding, direct object marker -et is used significantly less often by children with SLI. The two groups do not differ, however, in their overall percentages for either present or past tense inflections or in the distribution of these forms among the different number and gender forms.

A consideration of the features most difficult for SLI children reveals that these are similar to the elements which are late to emerge and are the source of many errors in the normal acquisition process. This is the case with English morphology as well as with Italian freestanding articles. The fact that children with SLI show grammatical profiles consistent with the input language with reductions in predictable areas of frailty, whereas there are no language-independent, universal areas of vulnerability, suggests that it is not the underlying grammar itself that is directly responsible for this disorder.

In order to further investigate the nature of the underlying grammar in SLI, Eyer and Leonard (1995) analyzed a single child’s production according to Radford’s (1990) developmental theory of functional categories, which is within the Principles and Parameters approach. Given the familiar difficulties with morphology in English-speaking children with SLI, the expectation was that if there was a structural deficit in grammatical representations, it would manifest itself in the functional categories and their maximal projections DP, CP or IP.

From the first phase of data collection there is evidence in this child for elements associated with the DP, such as articles, the determiner that and the case-marked my. The genitive -s, however, is absent altogether and there is a limited use of elements belonging to the CP. For example, there is hardly any use of wh-movement. Similarly, there is little evidence for I elements such as infinitive to or auxiliary be. Nominative case assignment to pronouns, which is associated both with the D-system and with the I-system was seen in only 47% of obligatory contexts.

The second phase of data collection gives clear evidence of all three functional categories. There is increase in the use of articles in obligatory contexts, several instances of wh-questions, modals in the past and the present tense, auxiliary do, infinitival to and be forms. There is a greater variety of nominative forms and the use in obligatory contexts increases to 71%. Eyer and Leonard (1995) conclude that while the child’s usage of functional elements did not match those of MLU controls, development was going in the right direction albeit at a slow pace. Consequently, there is no justification for arguing that the child’s grammar was aberrant.

5.2.4. How do the different hypotheses fare?

A particularly interesting test case for the various theoretical accounts of SLI is the study of LE, an Inuit girl with SLI (Crago and Allen, 1996) whose language,
Inuktitut, exhibits a high degree of polysynthesis with prolific verbal and nominal inflections. A nominal or a verbal root may be followed by up to eight morphemes corresponding to (English) independent verbs, auxiliaries, deverbals, denominals, adverbial, adjectives, an obligatory inflectional affix and optional enclitics. In addition, there are over 1,000 verb and noun internal productive morphemes that serve as nominalizers, verbalizers, valency changers and modifiers. Nouns and verbs are inflected for a variety of agreement markers and there is no uninflected infinitive.

Crago and Allen (1996) consider the hypotheses that have been proposed in the literature in view of the data from Inuktitut:

The Missing Features and Implicit Rule Formation deficit (Gopnik, 1990, 1994): in line with the predictions of the Missing Features deficit, LE's production shows a pattern of optional use of grammatical features in that the same verbal inflection appears in some obligatory contexts but not in others. In its revised formulation, i.e. the Implicit Rule Formation hypothesis, it is predicted that characteristic errors in the misapplication of rules will occur. For example, due to compensatory non-linguistic mechanisms, forms that encode conceptually tangible information, such as plural, will be used appropriately, while forms that mark less conceptually tangible information, e.g. agreement, will be more vulnerable. This hypothesis may account for LE's use of overt pronouns to mark person, as well as for her pattern of lexical search and her omission of obligatory inflections on both verbs and nouns. Note, however, that none of these hypotheses can account for LE's frequent insertion of the -mi morpheme. The inflection mi is frequently used on Inuktitut nouns as the singular locative ending ('in'), or as the singular modalis case ending, and occasionally on verbs as an internal morpheme meaning 'also', but it can never appear at the end of verbs or locatives as it does in LE's language.

The Extended Optional Infinitive hypothesis (EOI; Rice and Wexler, 1996): the Inuktitut data do not bear upon the EOI hypothesis, simply because tense in not implicated in the Inuktitut verbal inflection system. Indicative verb forms may be interpreted as either present or past, depending on the stem and the context. Time is represented by adverbs, some of which interpreted as verbs, which are affixed to the verb stem. The marking of time is completely independent of the morphological marking of number and person. Nevertheless, morphologically bare roots, which are ungrammatical in adult Inuktitut (and therefore the production of bare roots does not constitute an OI stage) are sometimes produced by normal Inuit children at the one-word stage. In LE's production bare roots appear even beyond the two-word stage.

The Surface hypothesis (Leonard, 1989): LE's pattern of omission is unlike the prediction of this approach. LE omits salient morphological inflections, which are multisyllabic and stressed, much more often than do her matched controls. She also has no instances of consonant-only deletion – a common phenomenon in Inuktitut – but omits complete (i.e. syllabic) inflectional units. LE uses overt pronouns much more often than the controls and inserts the morpheme -mi as some kind of a filler rather than omitting it, as the Surface hypothesis would predict.

The Sparse Morphology hypothesis (Leonard, 1992, 1996), which predicts that a child learning a language such as Inuktitut, in which morphology carries the most useful information, will be relatively more proficient in her learning is likewise not
supported by the data. LE’s utterances differ dramatically from the utterances of her controls in the number of omissions of inflections of various kinds, often resulting in base stem forms that are ungrammatical in Inuktitut.

Let us further consider the status of the various hypotheses in view of crosslinguistic findings: whereas some of Clahsen et al.’s (1997) findings are consistent with the Implicit Rule Formation deficit, others are not compatible with this proposal. For example, Gopnik (1994) accounts for the fact that English children with SLI inflect most auxiliaries correctly for past tense while they miss on the -s of 3rd person present tense, whereas German SLI children are correct on the various forms of sein. On the other hand, high correctness scores for regular past in English, high correctness scores for regular preterite forms in German, low correctness scores of 3rd singular forms of auxiliary in English and occasional difficulties with V2 in German argue against the Implicit Rule Formation deficit.

Yet another critique of Gopnik’s (1994) account comes from Bishop (1994) who reports findings which contradict this model. Bishop (1994) observes the following error patterns: (1) the production of morphological markers is not random; errors are unidirectional, involving omission of an inflection in obligatory context; (2) overregularization errors are sometimes observed; (3) grammatical features differ in difficulty; (4) substitution of stems for inflected forms occurs with irregular as well as regular verbs and finally (5) errors of pronoun case marking are common and always involve production of accusative forms in a context demanding the nominative.

Equally problematic is the EOI hypothesis (Rice and Wexler, 1996). Clahsen et al. (1997) argue that while some of the crosslinguistic findings can be explained in terms of this hypothesis, other findings pose problems for this account. Thus, in line with the EOI hypothesis, low correctness scores are found on 3rd -s in English and on various subject-verb agreement endings in German, along with an extensive usage of bare stems. However, SLI children perform much better on overt tense marking than on subject-verb agreement and their correctness scores for tense marking in English and for preterite in German are significantly higher than those for agreement. Unlike the prediction of the EOI hypothesis, SLI children do not produce non-nominative subjects with finite verbs. This type of error is expected to happen if tense controls case assignment. The finding from English (Schutze and Wexler, 1996) that non-NOM subjects are produced by children with SLI in sentences with finite verbs in which Tense is present but Agr is not (i.e. past tense verbs), was not replicated in the data from English reported in Clahsen et al. (1997). Thus, the German data fail to support the EOI hypothesis.

Notice, that in all of the criticism listed in this section the arguments are in the form of additional findings from children who have been clinically diagnosed as

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Note that Rice et al. (1995) are forced to adopt an earlier version of Chomsky’s case assignment theory (Chomsky, 1981) according to which case is assigned by Agr and is independent of Tense. The obligatoriness of Agr for every NOM assignment and the optionality of Tense predict that children with SLI will achieve higher correctness scores on Agr-controlled inflections, such as 3rd person -s, than on -ed, and this is clearly not the case.
having SLI, showing a different pattern than what has been predicted by a given account. Thus, while these criticisms indeed raise questions concerning the relative success of the various proposals in accounting for the syndrome of grammatical SLI, they do not necessarily challenge the correctness of these models with respect to the specific cases that they purport to explain.

In a different vein, Bishop (1997) lists three general arguments which are brought up against a processing account of SLI: (1) grammatical problems have been noted with written as well as with oral language; (2) individuals with SLI can accurately discriminate between inflected and uninflected words, hence their problem cannot be auditory-perceptual, and (3) there seems to be no direct correlation between perceptual salience of a morphological marker and its risk of being impaired. Rather, the difficulty varies with grammatical function.

With respect to the first line of criticism, Bishop (1997) argues that numerous studies have shown that written language is parasitic upon spoken language in development. Consequently, it is not surprising that children with SLI have problems with written language as well. As for the second critique, the problem lies in the nature of the task. Discrimination in test situations requires fewer resources and is not equivalent to discrimination in on-line, non-optimal conditions under which normal language is perceived. A similar problem arises with on-line phonological segmentation and the ability to tell speech sounds apart. With respect to difficulties encountered by children with SLI in morphemes that serve specific grammatical functions, Bishop (1997) argues that it is quite likely that a problem in perception at an early stage of input will interfere with acquisition of those parts of syntax signaled by the hard-to-perceive elements.17

5.2.5. Summary and conclusion – Children with SLI

SLI is a clinically defined syndrome. This means that diagnosis is made on the basis of standardized tests resulting in groups which are not necessarily theoretically interesting. Even when restricted to ‘grammatical SLI’, there remains a significant heterogeneity that precludes a view of the syndrome as a unitary one. In fact, there is no a-priori reason to believe that SLI can be characterized by reference to a single cluster of deficits.

17 Although we have restricted our review to ‘grammatical SLI’, if auditory processing deficits can be shown to exist in children with SLI, this may constitute an important factor in the explanation of the deficit. Tallal (1990) advocates the view that the underlying deficit in these children is not specific to the auditory modality but is a more general impairment in processing rapid transient information. Because language learning depends critically on the ability to detect rapidly changing auditory signals, the impact of this multimodal impairment will be particularly pronounced in the verbal domain. In general, the phoneme contrasts that children fail to make in their expressive speech are between sounds characterized by rapid transitional information. While controversy over this work continues (see Bishop, 1992), Tallal and colleagues (Merzenich et al., 1996; Tallal et al., 1996) have introduced an intervention program designed to train children to discriminate stimuli on the basis of brief acoustic cues. Improvements on identification of segments of synthetic speech sounds were paralleled by gains in language tests. While this work has excited considerable controversy, if the early promise of the method is fulfilled, this will provide support for the view that the linguistic difficulties of these children are secondary to more fundamental auditory limitations.
There are currently four major theoretical accounts of SLI that offer structural characterization of the deficit: The Agreement Deficit account (Clahsen, 1989; Clahsen et al., 1997) argues that SLI children have problems with optional non-interpretable phi-features of verbs, i.e. verb agreement features are affected. Problems with case features, with movement and with tense features are also expected.

The Implicit Rule Formation deficit (Gopnik, 1994) argues that children with SLI cannot reliably formulate implicit grammatical rules such as grammatical number and syntactic tense. In the absence of such rules, the children rely upon conceptual rather than linguistic mechanisms to guide their usage of language.

The Extended Optional Infinitive Stage (Rice and Wexler, 1996) builds upon the assumption that similar to normally-developing children, children with SLI show an OI stage. What distinguishes children with SLI is (a) a later-than-expected emergence of the targeted grammatical forms; (b) once finiteness emerges, a lower-than-expected use of finite forms where the adult grammar requires these forms; and (c) a longer-than-expected period of OI, perhaps into adulthood.

A Representational Deficit with Dependent Relationships (van der Lely, 1994, 1996; van der Lely and Stollwerck, 1997) is an account of grammatical SLI in terms of a modular language deficit involving syntactically dependent relationships between constituents. It is argued that for all syntactic functions, such as movement, agreement, and case assignment, involving relations within a local domain, the simpler the phrase-structure tree, the greater the possibility that any constituent within that tree could be realized correctly.

Overshadowing all those explanations in which underlying grammatical representations are implicated is the fact that language in SLI seldom demonstrates a complete lack of knowledge of rules. While statistical differences do exist, favoring particular constructions over others, children with SLI typically behave as if they possess grammatical principles but are shaky in applying that knowledge. Findings to this effect have been reported in all the work done in this area and are particularly clear when on-line performance is considered. The processing of large amounts of rapid auditory information invariably results in non-uniform production and comprehension. The amount of material and the rate at which it comes in seem at least as important as syntactic complexity in determining the errors of children with SLI (Tallal, 1975; Leonard, 1997).

5.3. Linguistic abilities in retarded children

5.3.1. Christopher, the polyglot savant (Smith and Tsimpli, 1995)

Christopher is a high-functioning autistic young man with a below normal performance IQ who has an amazing talent for languages. Christopher is described by his family as having had an obsession with languages from an early age which persisted into adulthood. Yet, Christopher has an exceptionally good memory for facts from various other domains, an issue that may be important when we consider the relevance of this case to the Modularity thesis.

Summarizing extensive testing of Christopher’s knowledge of English, Smith and Tsimpli (1995) argue that Christopher’s linguistic competence in his first language is
as good and as sophisticated as that of any native speaker. Nevertheless, while his English is good enough to allow him to pass some tests of inferential ability, there are linguistic abilities which lie outside his capabilities. In addition to problems with reference and discourse structure, the authors note problems with a range of phenomena, related to interpretive use and involving second order meta-representation (Wilson and Sperber, 1986).

The most interesting aspect of Christopher's linguistic abilities is his knowledge of 'second' languages including his abilities to translate. There is no doubt, however, that Christopher's second language grammars are not comparable to his English grammar. His knowledge in languages other than English is far from native-like with similar problems arising in all relevant languages. Two major points arise: first, there is a difference between his mastery of lexical and morphological knowledge on the one hand, and his mastery of syntax, on the other. Second, there is considerable influence of English on his judgments in other languages, and this influence gives rise to inappropriate performance. In fact, Christopher's syntax seems basically English, with a range of alternative, language specific options. Although Christopher's exposure to second language input has been considerable, the analysis and integration of this input into competence grammar has not been adequate. Rather, his L2 syntax seems to reach a plateau beyond which it cannot advance and is bound to remain imperfect. This is in marked contrast with his knowledge of second language lexicons, where his abilities appear to be closer to those of native speakers.

In Smith and Tsimpli's (1995) view, Christopher's translation, more than any other aspect of his linguistic talent, makes it clear that there is some radical dissociation between the various components of his linguistic competence. Christopher has significantly greater difficulty with morphologically complex items than with simple, monomorphemic ones. He fails to integrate his lexical ability into his processing of sentence structure and shows a concomitant ignorance of contextual relevance. That is, Christopher provides a translation on a word-for-word basis, even though when explicitly asked he shows the required knowledge which, if correctly integrated, would have resulted in appropriate translation.

Christopher's partial mastery of invented languages supports the previously established distinction between his knowledge of morphology and the lexicon and his knowledge of syntax. There is clear indication that in the invented languages too, the learning of morphology and the lexicon is different from the learning of syntax. While Christopher is inferior to controls in learning arbitrary syntactic patterns, he is better than controls in learning anomalous agreement paradigms that had overt morphology.

Smith and Tsimpli (1995) argue that Christopher's language provides support for the role of transfer from the first language, for the exploitation of morphologically defined learning strategies, and for the importance of UG. The latter is evident in Christopher's assumptions that the invented language he was exposed to was Pro-drop, presumably because it had a rich inflectional system. The fact that the second language learning exploits inductive strategies as well as modular capabilities is obvious from Christopher's success in applying inductive learning strategies only to linguistic items that are morphologically marked.
Taken together, the evidence suggests a dissociation between Christopher’s knowledge of words and of morphology and his knowledge of syntax in all but his native tongue. In order to account for this dissociation, Smith and Tsimpli (1995; Tsimpli, 1996) propose a psycholinguistic model which separates the linguistic lexicon from the conceptual one and syntax from morphology. The argument is the following: in line with Radford (1990), the authors assume that functional categories develop in the course of acquisition as a function of a process of maturation which is innately determined and is independent of the language the child is exposed to. A problem arises, however, with the empirical predictions that follow from this approach. Radford’s (1990) approach predicts that there will be no difference between children acquiring languages with rich morphologies (e.g. Hebrew), and those acquiring languages with poor morphologies (e.g. English), in the rate of acquisition of morphological markers. However, studies of children acquiring languages with rich morphologies invariably show that, unlike the case in English, morphological forms emerge early and are not a source of specific difficulties for children acquiring these languages (Tsimpli, 1996; Levy, 1997).

In view of these data, adherence to a developmental, or rather a maturational theory, of tree-structure – in which it is assumed that children begin with a truncated tree-structures and functional categories emerge at a later developmental stage (Radford, 1990) – requires that morphological constraints be defined as separate from syntactic ones. Alternatively, if morphological realization corresponds to syntactic availability, the question that needs to be answered is why the same functional category emerges or matures in one language earlier than in another (Smith and Tsimpli, 1995: 25).

Notice that this problem arises only if one adopts a strong maturational view, which sets a fixed timetable for the maturation of functional categories such that maturation is independent of the effects of input. A weaker version of this hypothesis, namely one that assigns a role to input in setting the pace of specific grammatical developments, would not entail a dissociation of the underlying functional categories from overt morphological marking. Smith and Tsimpli (1995), however, reject this possibility and argue that the sense in which certain patterns of ‘rich’ morphology are stronger triggers of development than other, ‘poorer’ patterns, has not been adequately specified.

The above developmental considerations along with the fact that linguistic theory has always maintained that certain morphological properties and operations were distinct from syntax, led Smith and Tsimpli (1995) to propose that functional categories and their morphological realization be kept separate, each belonging to a different component of the grammar. While the functional categories belong to the syntax, morphological paradigms, along with the linguistic lexicon, constitute an interface level between the grammar and the conceptual/mental lexicon (Tsimpli, 1996). The mapping of concepts and conceptual structures onto words and argument structures in a given language is carried out in this interface module, in which the morphological realization of both functional and substantive categories is found.

The postulation of separate components for functional categories and for their morphological realizations offers a way of describing the dissociation seen in
Christopher between his impressive lexical and morphological abilities on the one hand, and his less adequate syntactic abilities, on the other hand. Assuming these dissociated levels and the evidence showing that each level can be selectively impaired, one can indeed consider Christopher's language performance as a demonstration of internal modularity. Notice, however, that the theoretical rationale for this model relies, in part, upon a strong maturational approach to the development of hierarchical tree-structure (Radford, 1990), a position which has aroused many objections among researchers in the field of language acquisition.

Crucially, however, the case of Christopher does not concern what we have called 'big' Modularity, since, for the most part, Christopher's linguistic abilities give clear evidence of conceptual clarity and social relevance. In other words, none of this is solely linguistic. Furthermore, his facility with words and morphological paradigms, yet not with syntax, in the many languages with which he is familiar, strikes us as related to his obsession with foreign currencies and with scores on sports games, in that in all of these cases exceptional memory is crucially implicated. All this said, we do not wish to retract from the fact that Christopher's amazing talents indeed present an enigma. Although similar to the puzzle one is faced with in the presence of exceptional talents in normal individuals, Christopher is in fact, even more puzzling because he can outperform the average person when it comes to languages, yet he does it with a less than average intelligence.

5.3.2. Williams Syndrome

Williams Syndrome (WS) is a rare autosomal dominant disorder (1:20,000 to 1:50,000 live births) characterized by typical facial dysmorphism, renal and cardiovascular anomalies, mild to moderate retardation, statuary deficiencies, characteristic dental malformation and hypercalcemia (McKusick, 1988; Williams et al., 1961). The full-scale IQ of WS individuals is typically in the mild to moderate retardation. The cognitive profile of individuals with WS is characterized by "peaks and valleys of abilities within and across domains of higher cognitive functioning" (Bellugi et al., 1994: 23).

Detailed studies of English speaking WS adolescents which used non-standardized probes along with the more familiar test batteries, have shown significant impairments on various cognitive tasks. In marked contrast to their poor performance on these, WS adolescents and adults show a sparing of syntax both in comprehension and in production, which extends to tests of metalinguistic abilities as well. Morphological markers are generally used correctly, including markers for tense and aspect, as well as auxiliaries and articles. WS individuals exhibit an unusual semantic organization: while they have a considerable and sometimes exceptional knowledge of words, they often use this ability in deviant ways, either by having a disproportionate percentage of uncommon words or by picking on contextually unusual word choices. Mervis and Bertrand (1994) explain the lexical knowledge seen in WS as a consequence of their exceptional auditory memory.

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18 For arguments against the theoretical position of the authors, see a review of Smith and Tsimpli (1995) by Bates (1997).
WS narratives tend to be well formed and their stories abound in narrative enrichment devices and in affective devices (Bellugi et al., 1994). While the unusual conversational skills of WS individuals are indeed non-controversial, particularly as one compares them to other retarded groups, the nature of their underlying linguistic competence has recently been questioned.

Mervis et al. (in press) present a systematic study of language abilities in a large group of children and adults with WS. The findings show a normal correlation between mean utterance length and syntactic complexity. The pattern of findings from the TROG (Test for Reception of Grammar; Bishop, 1989) shows that overall, comprehension of syntax is relatively preserved in individuals with WS. However, performance on most complex structures is poor. A comparison between performance on language tests and performance on other cognitive tasks reveals that the level of grammatical ability is consistent with the level of composite mental abilities. In other words, despite apparent dissociation, language abilities correlate with abilities on non-language tasks. While the observed IPSyn (Index of Productive Syntax; Scarborough, 1990) scores were significantly higher than would have been expected on the basis of spatial constructive ability, they were significantly lower than would be expected based on receptive vocabulary ability, overall verbal ability, or short-term memory ability. That is, productive syntax is less advanced than either vocabulary or short-term memory.

Studies of WS children acquiring Italian suggest that there may in fact be morphological impairments in this population (Volterra et al., 1996). Furthermore, a recent study has suggested that the language abilities of children with WS may not be different from what has been found in mental-age matched children with retardation of non-specific origin (Udwin and Yule, 1991). Karmiloff-Smith et al. (1997) argue that WS rule-based knowledge of French gender agreement does not equal that of language-matched controls. A replication of this study with Hebrew speaking WS children, however, suggests that there might be language-specific differences in this domain (Levy and Karmiloff-Smith, in preparation).

Clahsen and Arreola (1997) are the only ones, to our knowledge, who investigated WS children’s performance on tasks involving reversible passives and Binding. Knowledge of regular and irregular past tense in English was also investigated. While the WS children performed at ceiling on all conditions, achieving higher scores than the mental-age controls, they overapplied the regular -ed, even in conditions when the normal children would not use it, for example, on nonce verbs that rhyme with existing irregulars verbs.

Clahsen and Arreola (1997) argue that the computational system is selectively spared in WS, yielding excellent performance on syntactic tasks and on regular

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19 Mervis and Bertrand (1994) confirm the expected good performance of WS on tests of face recognition.
20 The TROG – Test for Reception of Grammar (Bishop, 1989) is a multiple choice test of comprehension of grammar, standardized on children aged 4–13 years.
21 The IPSyn – Index of Productive Syntax (Scarborough, 1990) is a measure of the emergence of syntactic abilities ranging from single word usage to embedded clauses.
inflections, whereas the associative memory system and the access mechanisms required for irregulars are impaired. Note that these findings argue against all the findings reported so far in which auditory memory is reported to be better in WS than in aged-matched controls (Mervis et al., in press). WS children's exceptional memory is believed to be implicated in their knowledge of words, in their ability to rote-memorize passages and in their memory for names and for events.

Summarizing, recent studies of children with WS have highlighted the fact that, as expected, there is considerable variance among individuals with this syndrome including many cases in which language skills are hardly impressive. Crucially, however, investigation of sophisticated syntactic structures of the kind that have been studied in SLI, e.g. coreference and movement operations, has barely begun in children with WS syndrome. Thus, at present, we still do not know the exact nature of the linguistic strengths and weaknesses of individuals with WS.

5.3.3. Summary and conclusion – Language in individuals with uneven cognitive profiles

The issue of the relevance of syndromes to the study of normal cognition, brought up in the Introduction, is central to a discussion of findings from individuals with genetic disorders including WS. Whereas SLI is a clinically defined syndrome and as such it is quite likely that future refinements will result in a division of SLI into few yet, hopefully, unified behavioral profiles, genetically diagnosed syndromes present the problem in its clearest formulation. Despite the fact that a specific genetic disorder is at the origin of the observed deficit, the behavioral manifestations present a characteristic variance. Consequently, while individuals within a given syndrome may show breakdown along lines predicted by a specific cognitive model and this behavior will fall within the variance seen in that syndrome, it is unlikely that any specific behavior will generalize to the disorder as a whole. The recent debate concerning the theoretical status of findings from WS, reviewed above, should be seen in this light. That is, the question of the cognitive profile that adequately characterizes the syndrome is separate from questions related to the linguistic profiles of individuals with WS.

Smith and Tsimpli's study of Christopher (1995; Tsimpli, 1996) is an impressive example of the potential theoretical contribution of case studies. Smith and Tsimpli (1995) propose a psycholinguistic model that separates the linguistic lexicon from the conceptual one and syntax from morphology. Their suggestion that the syntactic functions of morphology constitute an independent level which is distinct from the morphological realizations of these categories is an intriguing proposal. Further research is required into the consequences of the postulation of this extra level of representation.

The central theoretical issue, however, with respect to language in individuals with congenital retardation concerns Modularity. The developmental cases reported to date may indeed support internal modularity, that is, specific aspects of the grammar seem to be modular. However, none of the reported cases, in our view, support 'big' Modularity as functional dissociation is not interchangeable with Modularity.
Clearly, cognitive profiles can be uneven. However, Modularity is a much more specific claim which is not exhausted by reference to dissociations among functions. The developmental cases have failed to provide support for the claims associated with Fodorian Modularity. Thus, while Christopher and the children with WS are indeed amazing cases of the fractionation of cognition, their performance would not have been possible in the absence of a relevant and functioning conceptual system. The issue that arises with respect to their unique cognitive profile is not that of the Modularity of grammar. Rather, it concerns the success of the linguistic modality to exploit whatever mental resources are available to these individuals, in the face of failure to do so when tasks of other types are attempted. Nevertheless, while the findings of dissociation of function are indeed trivial in the context of adult acquired syndromes, the fact that dissociations can be the result of congenital conditions is important in view of the hypothesis of brain plasticity.

6. Where do we stand?

6.1. Basic hypotheses

Linguists prefer to study language in happy and healthy adult speakers. This is understandable, for similar to the study of language acquisition, the study of language in pathology introduces a host of problems which are supposedly outside the domain of linguistic inquiry, but which, nevertheless, threaten to render the whole inquest uninterpretable. Not surprisingly, the logic, the argumentation and the divisions in developmental studies are very similar to the scene in the acquired aphasias. Thus, the relevance of data from pathology, whether acquired or developmental, to models of normal functioning requires that the Fractionation hypothesis as well as the Transparency hypothesis be taken as axiomatic (McCloskey and Caramazza, 1988). A further hypothesis is required in order to establish the relevance of developmental data, namely, that of Strong Plasticity – the assumption that the course, as well as the outcome of language acquisition, is not affected by the deficit in any significant way. Surprisingly, researchers in the field of developmental pathologies have not paid attention to issues related to brain plasticity, although without such an assumption, data from development remain uninterpretable.

Clearly, in order to gain theoretical insights from pathology, syndromic generalizations need not be attempted. Syndromes are clinically defined and as such they show variability in behavior which is often uninterpretable within existing cognitive models. While this is a relatively easy problem – one must simply give up the syndromic vocabulary and concentrate on individual patients – a more difficult issue concerns the need to account for the probabilistic nature of patients’ behavior and for the variability seen across tasks and often even between testing sessions.

6.2. Types of accounts

At the moment, the field divides into structural accounts of language breakdown stemming from strong innate views of linguistic competence, and accounts that are
stated in terms of processing factors which are typically non-linguistic, such as memory and speed of computation. The inconsistent behavior that is so often observed in patients can naturally be accounted for within processing models of language breakdown. However, linguistically interesting explanations may be equally promising in this respect provided that the focus is shifted from grammatical structures to grammatical processes, and from talk about ‘missing pieces’ to descriptions in terms of non-optimal grammatical procedures, within which variability in performance across tasks and even across sessions can be accommodated.

Some of the proposals reviewed here may indeed be seen as offering such a perspective. For example, patients’ inconsistent behavior need not present an in-principle problem to accounts such as Mauner et al.’s (1993) which explain agrammatism in terms of a deficit in computing syntactic dependencies. While linguistic structures remain central to the description of the deficit as conceived by Mauner et al. (1993), it is the dynamic process of computation that is at the root of patients’ failure to perform normally. In a similar vein, the deficit described by the RDDR (van der Lely, 1994, 1996), i.e. SLI children’s inability to consistently organize complex dependencies despite the fact that the structural underpinnings are available, refers to processing within the grammar as the main cause of the disorder. The EOI hypothesis too (Rice and Wexler, 1996) is stated in processing terms, if by that it is meant dynamic processes that determine the interaction between optional and obligatory rules of the grammar in children with SLI.

The dynamic nature inherent in Optimality Theory (OT; Archangeli, 1997) offers a natural way of conceptualizing the idea of processing that is internal to the grammar. In OT, language variation is characterized as different rankings of the same set of universal, yet violable, constraints. Specific patterns are derived from the language-particular ranking of these constraints. Markedness is inherent in the model and its specific aspects result from the ranking of constraints. Thus, OT eliminates the notion of a rule entirely, substituting it with the idea of constraint-ranking which is specific to each language. Under OT, part of acquiring a language is the acquisition of the critical constraint-ranking of that language. Since constraints interact and evidence for a particular ranking may not always be available, it is predicted that a child will go through stages which will reflect an incorrect ranking. At present, the ideas that are expressed in OT are still not fully developed in the domain of morphosyntax and detailed predictions with respect to language breakdown are not yet forthcoming. However, the dynamic nature of the process of rank-ordering and its potential for variation suggests possible loci of deficits and ways of accounting for the inconsistencies seen in performance under pathology.

6.3. Meta-theoretical issues

Linguistic theories of all persuasions distinguish among the following five levels of analysis – phonology, morphology, syntax, semantics and pragmatics. The usefulness of this conceptualization of language cannot be taken for granted in psycholinguistics of both normal and pathological populations. We have referred to such questions as meta-questions but have found little research on these issues. Smith and
Tsimpli’s (1995) proposal that lexical and syntactic functions of morphology be considered as separate levels of representation is an example of such a meta-theoretical contribution. In our view, data from pathology may be very valuable in clarifying such issues.

A central meta-theoretical question concerns the issue of Modularity. A review of the literature suggests that in all the instances in which language was dissociated from general intelligence, this dissociation could not be described in terms of Fodorian modules. This is so, since performance that will be interpretable by the usual research tools is not likely to be modular in the ‘big’ sense of the term. We therefore conclude that ‘big’ Modularity, in the sense of Fodor (1983), is not an empirical question; rather, it must remain a theoretical frame for which one may adduce plausibility arguments but not provide empirical refutations. On the other hand, internal modularity, i.e. the modular organization of specific parts of the grammar, is indeed an empirical question, and as such it has gained support in numerous studies of both agrammatism and SLI, as summarized in this article.

6.4. Principles and parameters

What are the linguistic properties for which evidence has been adduced from patients with neurological impairments? Most of the theoretically relevant notions are related to the GB framework, perhaps because this is the better-articulated theoretical model within linguistics today, allowing for specific, testable hypotheses. Unfortunately, none of the current accounts of either acquired or developmental language breakdown can be considered as generally accepted in the field, in which shared positions are rare and diversity of opinions prevails. However, looked upon from the perspective of linguistic theory, it is clear that specific linguistic entities and processes have indeed been instrumental in accounts of language breakdown.

Models of pathology typically refer to near-axiomatic assumptions within the GB framework, such as the lack of one-to-one mapping between the semantics of argument structure and syntactic frames; the need to assume di-structures as distinct from s-structure; the postulation of different underlying structures in active sentences, verbal passives and adjectival passives. While it may be of interest to demonstrate the relevance of these notions in the description of language breakdown, their status within linguistic theory does not require further empirical demonstrations.

However, more controversial notions have been discussed as well. Thus, the Trace Deletion Hypothesis (Grodzinsky, 1995a,b) refers to the movement of constituents, traces, and syntactic chains. It examines the relevance of the notion of a Thematic Hierarchy and the VP-internal subject hypothesis and posits a different status to referential and non-referential expressions. The Double Dependency Hypothesis (Mauner et al., 1993) makes use of the notion of thematic and non-thematic coin-dexation. Hagiwara (1993) discusses the Head-initial/Head-final parameter, the directionality parameter of theta-assignment, and the distinction between internal and external arguments of verbs. The Tree-Pruning Hypothesis (Friedman and Grodzinsky, 1997) provides support for Pollock’s (1989) argument that tense and
agreement must be split in the syntactic tree and strengthens the idea of a hierarchical structure of functional categories (Hagiwara, 1995).

Clahsen et al.’s (1997) Agreement Deficit account is stated in terms of interpretable and non-interpretable features (Chomsky, 1995). The functional categories of tense and number, verb-raising and the operation of feature-checking form part of the Implicit Rule Formation deficit (Gopnik, 1994) and the EOI (Rice and Wexler, 1996). The RDDR (van der Lely, 1994, 1996) demonstrates the relevance of Binding theory. Finally, the case of Christopher (Smith and Tsimpli, 1995) promotes a discussion concerning the differences between the syntactic and the lexical roles of morphology.

In sum, the above list suggests that, while disagreements abound and many questions are still unanswered, the study of language breakdown is fulfilling its promise in serving as a natural laboratory in which linguistic theories may be tested.

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