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What Underlies Inflectional Error Patterns in Genetic Dysphasia?

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Abstract

We compare linguistic and non-linguistic explanations which attempt to account for the difficulties that individuals with genetic dysphasia experience with inflectional morphology. The non-linguistic explanations that we focus on are low performance IQ and performance deficits which are manifested at the level of auditory processing or at the mapping between representation and articulatory output. We argue that none of these hypotheses can account for the patterns observed; the impairment lies in the construction of the grammar itself. We hypothesise that the dysphasic grammar lacks sub-lexical (morphological) features which mark inflectional information in languages. Consequently, the grammar does not contain the morphological rules which introduce these features and, following from this, there is no structure internal to 'inflected' words. We summarise the experimental evidence which supports this hypothesis.

1 Introduction

The observation that individuals with Specific Language Impairment (SLI) have particular problems acquiring their native language is undisputed. Recent evidence has shown that in a subset of individuals with SLI, the impairment is associated with some genetic factors (see e.g. [1-3]) and data from MRI studies have revealed neurological anomalies in some impaired individuals [4, 5]. In light of this research, we will henceforth refer to the impairment in this sub-population as Genetic Dysphasia (or GLI).

Two broad positions have been advanced in recent years to account for the particular problems that dysphasic individuals have with language. One set of explanations proposes that this disorder directly affects the ability to construct a normal grammar (e.g. [6-10]). The alternative explanations propose that the language impaired individuals have no problem with the underlying linguistic system itself [11, 12]. Their apparent problems with language are instead caused by an auditory or articulatory processing deficit. This processing deficit distorts the mapping between linguistic representations and either the auditory input or the articulatory output of the grammar.

Over the past few years, our research group has collected a significant body of cross-linguistic data which is consistent with the grammatical deficit hypothesis. Objections to this explanation have been raised in the literature. The goals of this paper are therefore to clarify some of the misunderstandings surrounding our claims, to correct some misstatements of fact, and most importantly, to show that neither IQ, nor perceptual or articulatory processing deficits can account for the patterns of linguistic behaviour that are observed in the data.

The paper is organised as follows. We begin in Section 2 by introducing four hypotheses that have been advanced in the recent literature to account for the problems that impaired individuals experience in the area of inflectional morphology. In Section 3, we review the cross-linguistic evidence from which we argue that the problem lies in the *grammar*. We focus in particular on the representation of inflectionally complex words. This section includes some discussion of our assumptions about morphological structure in the unimpaired grammar; it ends with our views on the representation of 'inflected' words in the impaired grammar. In Sections 4 and 5, we provide detailed discussion of three alternatives to the grammatical deficit hypothesis, that GLI can be accounted for by low performance IQ (Section 4), or by performance deficits at the level of perceptual and/or articulatory processing (Section 5). In Section 5, we limit the discussion to those properties which are shared by both performance deficit hypotheses, and in Sections 6 and 7, we discuss each hypothesis in more detail. Finally, in Section 8, we report on the results of two experiments which challenge the perceptual deficit hypothesis.

1.1 Additional Deficits

1.1.1 Linguistic Deficits

Although much of the research on dysphasia has focussed on inflectional properties, it is apparent that the grammatical problems are not restricted to this area. For example, work on prosodic structure in English suggests that individuals with GLI cannot construct prosodic words which are larger than one foot ([13]; see also [14]). There is also some evidence for a more generalised syntactic deficit, one which manifests itself at all levels of phrase structure, multiple embedding, binding, etc. (see [15]). Further, there is no general agreement as to whether the inflectional problems lie exclusively in the syntax (see [6] on agreement; [9] on tense), or whether the morphological representation is also impaired (see [16-18]) as we will suggest here. It remains to be seen whether all of the linguistic difficulties which characterise this population can be reduced to a single deficit; nevertheless, this does not weaken the hypothesis that the impairment lies in the construction of the gammar.

1.1.2 Non-linguistic Deficits

Some language impaired subjects have problems *outside* the grammar as well: problems that can impede the processing and/or production of language, and problems that fall outside this domain, cognitive, motor, affective (see e.g. [19]). This is not surprising. There is significant evidence that GLI is associated with genetic factors, and preliminary evidence suggests that these genetic factors can interfere with normal neurological development (see [5]). It is well-known that genes can have many different effects and, thus, it is to be expected that some genes concerned with language can have pleiotropic effects and so not be 'specific' to language [20]. Moreover, MRI studies have shown that the brains of language impaired individuals can be significantly different from controls [21, 4, 22]. On the basis of these observations, it would be surprising if at least some impaired subjects had no other deficits.

Co-occurrence, however, is not causation. The crucial question for the linguistic hypothesis is whether the grammatical deficits that are observed are *caused* by any of these non-linguistic problems or whether they merely co-occur. An individual may have a problem with, for example, spatial rotation or articulation, and at the same time, have a specific grammatical impairment in an autonomous language module. The impairment in the grammar would be the direct cause of their language deficit; the other co-occurring deficits would be accounted for either by more general neurological damage or by some pleiotropic genetic effects. This is a strictly empirical question. The answer depends upon finding out whether specific deficits in language are related in a *law-like* way to specific deficits in some other domain. It could certainly be the case, but to date, no research has shown that it is. In this paper, we look at some of the speculations about non-linguistic causes for the linguistic disorder, specifically low performance IQ and performance deficits which are manifested at the level of auditory processing or at the mapping between representation and articulatory output. We argue that when the linguistic disorder is looked at in detail, these other purported causes do not make the correct predictions about what is wrong with language.

1.2 Grammars and Surface Forms

In investigating the effect that SLI has on the development of language, the first order of business is to provide a linguistically principled and comprehensive description of what is amiss in the language of impaired subjects. This kind of description is necessary before any proposal for the proximate 'cause' of the disorder can be assessed. We must begin by recognizing some fundamental properties of language. The first of these is that the observable surface phenomena of language are the product of an underlying grammar, an abstract system of rules and representations, and that it is this grammar that any linguistically principled account must characterise. The surface

forms produced by speakers may constitute evidence about the properties of the grammar, but these forms do not, in themselves, constitute language in the psychologically relevant sense.

Furthermore, the language of a subject cannot be characterised by examining one particular surface form in isolation because surface forms are produced by an interconnected system of rules and representations. Even if two subjects produce the same surface forms for some item, one cannot conclude *a priori* that the system that produces these forms is the same for the two subjects. It is the overall pattern of use that allows us to postulate the properties of the abstract grammar that are responsible for these forms and not the existence of individual surface forms. Differences in the pattern of use of surface forms may reflect very different grammatical systems. For example, the fact that impaired speakers sometimes produce "walked" in a temporally past context does not constitute sufficient evidence for the existence in their grammar of a morphological feature [+past] that is carried by the "-ed" suffix. It can equally be true that the word "walked" exists as a morphologically unanalysed chunk in their lexicon with the associated meaning "to move on foot in the past". No single test can decide between these two alternatives. The overall pattern of linguistic behaviour can be determined only from a variety of testing conditions. We will argue that the balance of evidence collected using different methodologies across several languages supports the second interpretation.

2 Hypotheses

2.1 SLI as a Grammatical Deficit

There is a significant body of literature which argues that SLI reflects a grammatical deficit. To date, no hypothesis can account for all of the problems that have been observed, but researchers who advocate this view share the position that individuals with SLI do not construct the same sort of grammar as do unimpaired individuals. Specifically, they accept the position that the problems observed cannot be reduced to processing difficulties or to non-linguistic deficits such as low intelligence. They argue that the impaired individuals have problems in the construction of the grammar itself. In this paper, we will pay particular attention to those properties of the grammar which fall under the domain of inflectional morphology. Briefly, we argue that the data support the view that the impaired individuals do not have sub-lexical features like [±past] and [±plural] in their morphological representations. As a result, they cannot construct the rules that operate on these features (cf. [23]).

2.2 Non-grammatical Hypotheses

As mentioned earlier, several interesting non-grammatical explanations for SLI have been proposed. Unfortunately, not all of them can be considered within the constraints of a single paper. We have therefore chosen to examine only three: performance IQ, articulatory processing, and auditory processing. We briefly introduce each of these explanations below, and then discuss them in more detail later in the paper.

2.2.1 Performance IQ

One of the explanations for SLI is that it is not really specific to language at all, but is instead caused by a more general cognitive disorder [19, 24, 11]. There have been a wide range of cognitive problems that have been suggested to be the direct cause for the language disorder, from deficits in hierarchical organisation to problems with spatial rotation. We will discuss only one of these problems here: the hypothesis that the language disorder is associated with low performance IQ. Under this hypothesis, it is proposed that if a subject with language problems also has a low performance IQ, then this second factor is sufficient to account for the problems with language.

This explanation presupposes that the ability to acquire language is not autonomous, but rather, is based on the same type of cognitive skills that are required to perform non-linguistic tasks like arithmetic and spatial inference that are measured by the standard tests for performance IQ. In order to eliminate the confounding factor of performance IQ, one of the defining criteria for the clinical diagnosis of SLI is that there be a significant difference, usually of 20 points, between the subjects' performance IQ and their language scores. The assumption underlying this hypothesis is that there is a significant difference between language impairment that is associated with normal or superior performance IQ scores and language impairment that is associated with low performance IQ. In the latter case, the low performance IQ provides a sufficient explanation for the language disorder.

2.2.2 Articulatory Processing

The second alternative to the grammatical deficit hypothesis we will consider is that articulatory processing difficulties account for the problems that language impaired individuals experience with grammatical morphology [25, 11]. Fletcher [25], for example, suggests that "the more likely source of the variable [linguistic] performance problems lies in the language-production processing system, rather than in the underlying grammar. Grammatical forms like plural, past tense and third person singular are particularly vulnerable in English, in individuals with phonological problems" (p. 226). This hypothesis assumes that the primary disorder is one of articulatory processing. The linguistic problems that are observed are merely an epiphenomenon of this performance constraint. The authors who propose this view do not make clear the status of "vulnerable" forms in the grammar. However, the likely reading of this claim is that the grammar is intact, and that an impaired subject says *Yesterday I walk* instead of *Yesterday I walked* because the segment that encodes the grammatical morpheme [+past] is difficult to articulate; the grammatical morpheme itself is unaffected, and impaired speakers presumably have the same representation for *walked* in their grammar as do unimpaired speakers.

2.2.3 Auditory Processing

The third alternative explanation that we will discuss is that individuals with SLI have auditory processing difficulties which limit their ability to perceive the non-salient sounds that encode inflectional morphology in English. While individuals with SLI can produce and perceive the phonetic content of words, their processing abilities are severely taxed when they must perceive non-salient sounds. As inflectional morphology in English is expressed by such non-salient sounds, impaired subjects are unable to build the appropriate morphological paradigms.

In some sense, this view is similar to the articulatory deficit hypothesis in that it assumes that the observed grammatical problems are the result of the "vulnerability" of the sounds that encode them: "children with SLI experience extraordinary difficulties in the area of morphology because many grammatical morphemes in English take the form of word-final nonsyllabic consonants and unstressed syllables that do not appear in positions (namely, clause-final position) in which significant lengthening occurs. Such morphemes have shorter durations than adjacent morphemes; hence, they may be more difficult to perceive. Because they are subject to final consonant deletion and weak syllable deletion, they are also challenging in production" [12, p. 92].

It is clear that both the auditory and articulatory deficit explanations depend on the claim that grammatical morphemes are encoded by "vulnerable" sounds. This predicts that the linguistic problems of language impaired subjects should be correlated with the phonetic properties of the sounds that encode such morphemes and not with their grammatical status. We will demonstrate that this prediction is false.

3 The Grammatical Deficit Hypothesis

The grammatical deficit hypothesis holds that the linguistic disorders observed in the dysphasic population are caused by an impairment in an autonomous language module. As mentioned earlier, we will focus here on problems with inflectional morphology. We hypothesise that the specific nature of this impairment is that dysphasic individuals do not build inflectionally complex representations because they do not have the sub-lexical features which encode inflectional information. Therefore, they cannot construct the rules that operate on these features. In this section, we will first show that similar linguistic problems are observed cross-linguistically and cross-modally. We will then present a wide range of converging evidence that demonstrates that the language impaired subjects do not have access to the internal structure of words. These data allow us to construct a hypothesis about the nature of the morphological representations in the lexicon of impaired subjects and how these differ from those of unimpaired subjects.

3.1 Cross-linguistic Similarities

We begin by briefly reviewing the extensive cross-linguistic evidence from which we have concluded that SLI reflects a grammatical impairment. Our research group has studied the linguistic behaviour of individuals diagnosed with GLI from four languages: English (in England and in Canada), Greek, Japanese, and Quebec French. In spite of the fact that these languages are structurally quite different from one another, a broad measure of performance across the language groups yields results which are strikingly similar. In Figures 1 and 2, it can be seen that the same pattern of strengths and weaknesses occurs for all four languages.[1,2] This has led us to conclude that the deficit we are describing is not a function of the linguistic properties of any particular language, but rather, that it reflects a more general problem with the ability to acquire language.

To investigate whether the behaviour observed in the GLI population does indeed reflect a grammatical deficit, that it cannot be reduced to performance factors or be attributed to task effects, we have made every effort to include data collected from a wide range of situations. Analyses have been conducted on spontaneous speech as well as on data which have been naturally and experimentally elicited. The naturally elicited data include letters written by several impaired subjects. For data which have been experimentally collected, we have carefully designed our tests to include a wide variety of different types of stimuli and responses. In some tasks, the stimuli are presented to the subjects orally, while in others, they are presented in written format; in some tasks, the responses are written, and in others, they are oral. In all of the languages that we have investigated, impaired subjects show similar grammatical difficulties across all conditions. They have similar problems in spontaneous speech and in experimental settings, so their difficulties cannot be attributed to the particular demands of the testing situation. Further, they make similar errors regardless of how the stimuli are presented and regardless of what type of response is required.

For example, we have convergent evidence which reveals that impaired subjects have difficulties with inflectional properties such as ‘tense’ in English, Greek, Japanese and French. They make similar errors when the stimuli are presented orally or visually, in writing or in pictures. The same pattern of response is found, whether they are required to produce an inflected form or to make a grammaticality judgement by saying “yes” or “no”, by circling a number, or by pointing

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[1] For a description of the five tasks in Figures 1 and 2, see [26] on English (in England), [27] on Greek, [28] on Japanese, and [29] on Quebec French.

[2] The reader might have noticed that the performance of the English and Canadian impaired subjects on the grammaticality judgement task differs markedly, 57.2% and 76.1% correct respectively. We suspect that this is due to the fact that the tasks were not identical; specifically, there were twice as many ungrammatical as grammatical sentences in the English version of the test, but equal numbers of grammatical and ungrammatical sentences in the Canadian version of the test.

to a picture.[3] The fact that there is so much consistency across all of these tests despite the differences in their form convinces us that individuals with GLI have a problem with the grammatical representations themselves and not with any input or output modality.

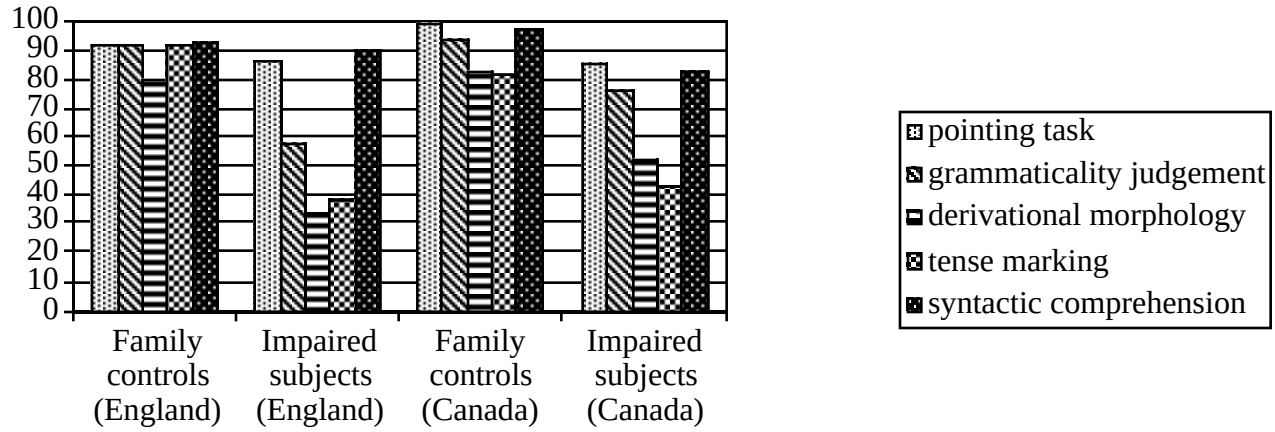

Figure 1. Results across five tasks in English

3.2 Lexical Representations

Impaired individuals sometimes do produce outputs that have the same surface form as inflected words. One of the strategies which they use to compensate for their impairment is to store words that are inflected in the normal grammar as morphologically unanalysed chunks. We will provide four different types of evidence in support of this hypothesis: 1. their inability to extract roots[4] from inflected words; 2. frequency effects; 3. on-line processing of inflected and uninflected words; and 4. the segmental and prosodic shape of inflected and uninflected forms.

3.2.1 Morphological Representations in the Unimpaired Population

First, we begin with some discussion of our assumptions about word structure in unimpaired populations. We accept the standard position that morphologically complex words are hierarchically organised into constituents. We adopt the strong lexicalist model in that we assume that all morphology takes place in the lexicon. We follow Williams [32] who argues that words are right-headed, and that features of the head percolate up to the dominating node; see (1a). Although we assume that regularly inflected words such as "walked" are morphologically decomposable, we assume that irregulars are not and are thus represented as in (1b).

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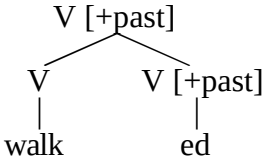
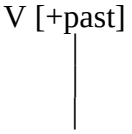
[3] In their paper, Vargha-Khadem et al. [11] have not cited any of the work conducted by our research group since Gopnik & Crago [26]. This has led them to mistakenly state that our conclusions about tense are based on ten items only. Since this preliminary work was undertaken, we have conducted many tests on tense in English and other languages which, together, include several hundred test items and all converge on the same analysis (see [30, 31] on English; [27] on Greek; [28] on Japanese; [29] on French).

[4] Here, we do not distinguish "root" from "stem" as it appears that, in the bulk of the literature on this population, investigations of inflectional morphology have involved stimuli where inflections attach to morphologically simple bases. We therefore will use the term "root," without making any claims as to whether individuals with GLI can distinguish "roots" from (derivationally complex) "stems" (but cf. [30]).

(1) a.



b.



3.2.2 Access to Roots

The most direct kind of evidence that indicates whether impaired subjects know the internal structure of words is their ability to demonstrate that they are aware of the morpheme boundaries between roots and affixes. If they recognise that some words are composed of roots and affixes, then they should be able to use the individual morphemes in constructing new words. English is not a good language to test this hypothesis, because uninflected forms like "walk" can surface as words. Greek provides an ideal test case because all nouns and verbs in Greek are inflected (for details, see Dalalakis [18]). Therefore, Greek children never hear the bare root in isolation. In order to discover the root form of the word, they must be able to abstract it from the inflected words that they hear. If they cannot extract the root, then this is evidence that they do not understand that words are composed of a root and an inflection.

In order to produce a compound correctly in Greek, speakers must abstract the root for the first element of the compound from the inflected words that they have heard. In addition, there is a linking morpheme *-o-* that surfaces between the two members of the compound, except when the compound itself is nominal and the second element is vowel-initial. If a speaker can reliably produce the root of the first member, then it is reasonable to conclude that the speaker is treating the inflected forms as if they are composed of a root plus an inflection.

As pointed out by Dalalakis [18], if a particular compound already exists in the language, like "wolfman" [Greek: *lik-anthropos*], the impaired subjects may be able to readily produce it because it might be listed in their lexicon as a morphologically unanalysed chunk. However, if they are asked to produce a novel word, like "mouseman" [Greek: *pondik-anthropos*], they should have great difficulty if they will be unable to find the root for "mouse".

Subjects were shown two pictures and told *Aftos ine enas pondikos. Aftos ine enas anthropos pu yinete pondikos otan ekhume panselino. Kseris pos ton leme? Ton leme _____?* "This is a mouse (nom sg m). This is a man (nom sg m) who becomes a mouse (nom sg m) when we have a full moon. Do you know what we call him? We call him a _____?" They were then asked to produce the appropriate compound.

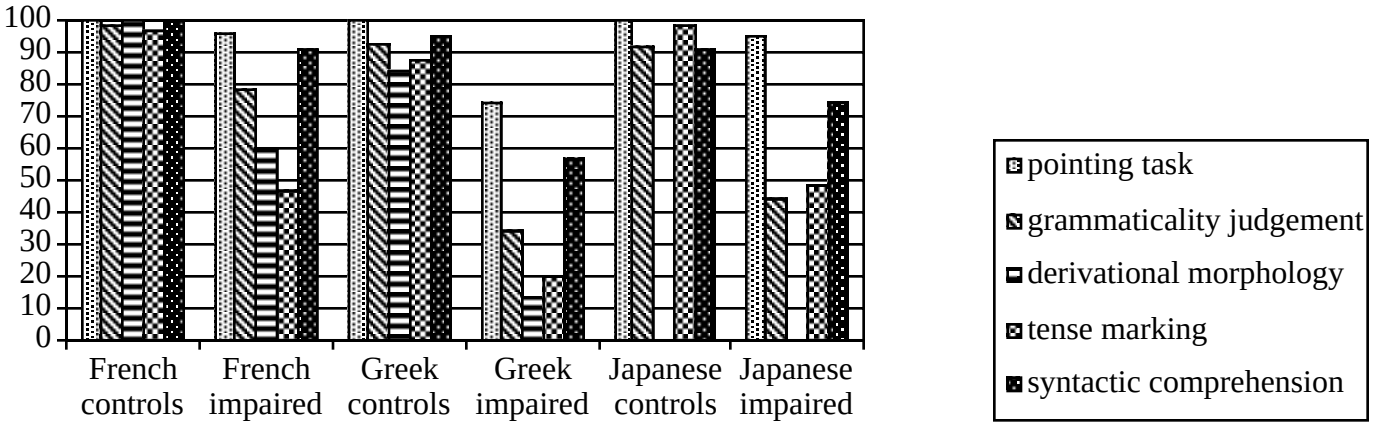


Figure 2. Results across five tasks: Greek, Japanese, and Quebec French

The data show that the language impaired subjects do not reliably know where the root boundary is. Sometimes they produce a form that is shorter than the real root (like [anthro-faghos] instead of [anthropo-faghos] "man-eater"), and at other times they produce a form that is longer than the real root ([hinoth-anthropos] instead of [hin-anthropos] "goose-man"). When they attempt to insert the *-o-* that signals the morpheme boundary, they often insert it at the wrong place. When we look at the types of errors that the subjects made, we find that the majority made by the impaired subjects are errors in finding the root. The majority of the errors made by the young controls are overgeneralisation errors where they insert *-o-* into a word in which it is not needed, but, importantly, they always insert it at the correct root boundary (see Table 1).

ERROR TYPE	IMPAIRED	YOUNG CONTROLS	AGE-MATCHED CONTROLS
Sum of Root Errors	83.9%	5.0%	1.3%
Overgeneralisation of *-o-*	3.8%	79.0%	12.0%

Table 1. Errors in Greek Compounding (from Dalalakis [18])

Recent tests with diminutives in Greek tell a similar story [18]. In a task that required the production of diminutives, 62% of the errors that were made by the impaired subjects involved producing a form that was either longer or shorter than the root. The age matched controls *never* produced such root errors. These data strongly suggest that the impaired subjects are not aware of the internal boundary between a root and its affixes.

3.2.3 Frequency Effects

Irregularly inflected words are standardly assumed to be stored in the lexicon as unanalysed wholes, while regularly inflected words are constructed in the grammar. If a word is listed in the lexicon, then its frequency should affect its retrieval. In several of our tests, we carefully controlled for frequency. The likelihood of the language impaired subjects producing an existing regular or irregular past tense verb in English was dependent on the frequency of the existing past tense form [30]. Similar effects were found in Japanese [10] and in French [29]. The fact that *regular* forms show frequency effects in the language impaired subjects suggests that they are storing inflected words as unanalysed chunks in their lexicons.

3.2.4 On-line Lexical Decision Tasks

One way to investigate how subjects process inflected words is through the use of on-line lexical decision tasks which tap into how representations are accessed and stored in the lexicon. On-line tasks have been conducted in English, French, and Greek and they all show that the impaired subjects process inflected forms differently from controls [33, 34]. In the impaired population, inflected words appear to be treated as chunks with no processing or decomposition of the inflectional suffix. These data suggest a full-listing interpretation where lexical entries are not morphologically decomposed in the dysphasic lexicon. This proposal would account for the occasional production of seemingly past tensed verbs in spontaneous speech or during testing.

3.2.5 Summary

The Greek compounding data, the frequency data, and the on-line data all reveal that the impaired subjects do not treat inflected words as if they are composed of separate constituents. Therefore,

when a language impaired subject produces a word like "jumped", it is likely that this word is not morphologically complex, but rather, is listed as an unanalysed chunk. The meaning usually carried by the inflection is simply incorporated into the semantic information of the whole chunk; i.e., "walked" has no feature [+past], but simply means "to move on foot in the past".

3.3 Rule-governed Behaviour

We suggested above that individuals with SLI lack the morphological features which mark inflectional information in languages (see Dalalakis [18] for a similar view). Two consequences of this are as follows: 1. the grammar should not contain the morphological rules which introduce these features; and 2. following from this, there should be no structure internal to 'inflected' words. In the following sections, we provide experimental evidence in favour of each of these hypotheses. Concerning the first, we demonstrate that the impaired subjects show no evidence of rule-governed behaviour, as concerns inflectional morphology. Specifically, unlike unimpaired controls, individuals with SLI are not able to readily inflect forms that they have never heard before (Section 3.3.1). When the experimental methodology forces them to provide 'inflected' forms, the forms that they produce are built through compensatory means (Section 3.3.2).

3.3.1 Inflection in Novel Forms

On occasion, individuals with SLI do produce seemingly inflected words like "walked" in spontaneous speech and in testing situations. To account for this observation, some investigators have argued that impaired subjects must have access to the grammatical rules which build these forms [35, 36, 37, 11]. In the previous sections, we have presented evidence that these forms are not composed of a root and inflection for the impaired speakers, but rather, they are lexically stored as unanalysed chunks. If, on the other hand, our hypothesis is wrong, and impaired speakers do build inflected words through the use of productive morphological rules, then they should be able to apply these rules to forms that they have never heard before. We have investigated this question across several grammatical morphemes in four languages. As can be seen in Table 2, in all cases, the controls were significantly better at these tasks than were the language impaired speakers.[5,6]

PAST TENSE	**CONTROLS**	**IMPAIRED**
English (K family)	91.7%	38.3%
English (Canadian families)	81.8%	42.1%
Greek	87.1%	20.0%
French	92.6%	33.3%
Japanese	89.1%	37.0%
PLURALS		
English (K family)	95.7%	57.0%
English (Canadian families)	99.2%	58.3%
Greek	79.8%	42.1%
DIMINUTIVES		
Greek	83.9%	40.2%

Table 2. Inflection of Novel Forms

[5] Henceforth, we will refer to the English-speaking subjects from England as the K family.

[6] For more information on the numbers in Table 2, see [30] and [31] on tense in English, [27] on Greek, [29] on French, and [28] on Japanese. For more on plurals, see [16, 17] on English, and [18] on Greek. For more on dimunitives in Greek, see [18]. In Table 2, we have included dimunitives among the class of inflectional affixes. In reality, they share properties with both derivation and inflection.

If the impaired subjects have no morphological rules available for building inflectionally complex words, one might wonder how they are able to perform even as well as they do. It must be the case that the seemingly inflected forms that they do produce are derived by means other than through the addition of an inflectional affix. In the next section, we suggest that this is indeed the case.

3.3.2 Compensatory Strategies

The numbers in Table 2 merely reflect the percentage of time a past-, plural-, or diminutive-like ending was added to a novel input, without any consideration as to whether the response sounded truly 'normal'. If the responses were the product of a rule-governed system, and were not arrived at through other means such as analogy, then we should find that the inflected forms of novels are segmentally and prosodically identical (in relevant respects) to the inflected forms of existing words. A detailed analysis of the plural outputs of a subset of the impaired adult members of the K family has revealed that this is not the case. Goad & Rebellati [16, 17] have classified the impaired plural-like outputs into two broad categories, 'Correct-sounding' and 'Other Sibilant-final', as exemplified in Table 3.

	TYPE OF OUTPUT	NOVEL	EXISTING
PLURAL-LIKE	Correct-sounding	10.3%	31.5%
	Other Sibilant-final	75.3%	62.1%
	Compounding	*65.3%*	*62.1%*
	Real Word Sub	*10.0%*	
OTHER	Omission	10.8%	5.9%
	Other	3.6%	0.5%

Table 3. Plurals across Five Impaired Adult Speakers by Type

While plural-type responses were provided a total of 85.6% of the time for novel words, only 10.3% of these had the correct segmental and prosodic shape of real plurals. This suggests that these forms have not been produced by the regular rules for inflection.

The precise segmental and prosodic shape of the remaining 75.3% of outputs can give us information about the strategies that impaired speakers use to compensate for their inability to use the unimpaired rule-governed system for producing inflected forms. As can be seen in Table 3, the category 'Other Sibilant-final' is itself divided into two sub-categories: 'Real Word Substitution', where a sibilant-final existing word (plural or otherwise) is provided in place of the plural of the novel word; and 'Compounding', where the derived structures do not involve affixation, but instead, reflect something akin to the concatenation of lexical categories. Examples of both strategies are provided in Table 4. (The examples come from a member of the K family who typically performs at the top of the impaired group.)

TYPE OF OUTPUT	EXAMPLES: NOVEL WORDS	EXAMPLES: EXISTING WORDS
Compounding	[drɑg] + pl → [drɒgs]	'cart' + pl → [kɔtsɪ]
	[bleʒ] + pl → [bléʒɪs]	'torch' + pl → [tɔtʃs]
Real Word Substitution	[spʌl] + pl → [spɛlz]	
	[ri] + pl → [ridz]	

Table 4. Examples of Compounding and Real Word Substitution

Real Word Substitution is entirely consistent with the hypothesis that impaired subjects have no means with which to produce an inflected word. They search in their lexicons for sibilant-

final words which are phonetically close to the target novel word. If these are stored as morphologically unanalysed wholes, we would expect that any sibilant-final form would do, regardless of whether the sibilant 'encodes' plurality. This is, in fact, what we find: 'lunch' is commonly provided as the plural for [lʌnt], as is 'bronze' for [brɑm].

Forms classified as 'Compounding' constituted 65.3% of outputs provided for novel words. These outputs included forms such as [drɒgs] where there is no voicing assimilation between the stem-final consonant and the plural marker, and [blézɜ̀ɪs] where the plural defines its own domain for stress. In Goad & Rebellati [16, 17], it is argued that a single explanation underlies both of these types of outputs: the derived structures do not involve affixation, but instead, reflect something akin to compounding, in other words, the concatenation of lexical categories. We suggest that these data indicate that the SLI grammar lacks the morphological rules which build inflectionally complex words. While impaired individuals may be able to produce plural-like outputs, these forms arise from different sources.

3.4 Morphological Representations in the SLI Population

All of the data discussed above are consistent with the hypothesis that individuals with SLI are unable to decompose inflectionally complex words. This suggests that words like "walked" are represented either as in (2a) or as in (2b). In neither case is there structure internal to the word; these representations differ, however, in where temporality is expressed. In the former, this concept is represented through the morphological feature [±past], parallel to the representation provided in (1b) above for the irregular "sung". In the latter representation, the concept of pastness is expressed in the semantic entry.

(2) a.

b.

Semantic Interp: "move on foot" "move on foot in the past"

We reject (2a) on grounds that there is no evidence that the lexical entries of impaired speakers contain sub-lexical (morphological) features for tense, number, and perhaps other inflectional properties (cf. [23]); as such, the grammar does not contain the morphological rules which introduce such material.[7] Given that regular pasts end in a coronal stop in English, and given that impaired individuals can add a past-like ending to novel words, we assume that these forms are stored in family resemblance classes for the impaired individuals and that they can thus perform 'Wug'-type tasks [40] through analogy (see [16, 17]). The relationship among "walked, watched, faxed, ..." in their lexicon is then formally identical to the relationship among "glisten, glimmer, gloss, ...", all of which express brightness, in the unimpaired lexicon.

The evidence we have against (2a) is as follows. If the feature [past] were present in the SLI grammar, we would expect the distribution of [+past]- and [-past]-marked verbs (at least those that impaired speakers know and have listed in their lexicons) to be identical to the distribution of these verbs in the outputs of unimpaired speakers. This is not the case. Instead, we find the following asymmetry in the productions of impaired speakers: "walked" appears in past contexts, and

[7] Our argument does not hinge on whether 'morphological rule' refers to Word Formation Rules which introduce specific affixes (cf. [38]), or to context-free phrase structure rules, in the sense of Selkirk [39].

"walk" appears in all contexts, including temporally past contexts. The impaired subjects rely heavily upon the use of temporal adverbs in place of overt marking of past tense (see [30]). If the concept of pastness were expressed in the lexical entry for "walked", rather than through the use of features, and if "walk" were to include no temporal marking in its lexical entry, then this is what we would expect.

We assume that plurals also lack internal structure along the lines of (2b). However, there is one thing that distinguishes nominal from verbal inflection in the outputs of impaired speakers: plurality is overtly marked more often than tense, in testing situations as well as in spontaneous speech (see Table 2 above). We cannot appeal to a phonological explanation for this difference, as in English, the allomorphy observed in plurals is identical to that observed in past tense forms. We suggest instead that a functional explanation underlies the difference. It has been shown that the relationship between the semantics of temporality and overt tense marking is extremely complex [41]. Temporal reference can be expressed without the use of an inflection, and under some pragmatically-determined conditions, there can be a conflict between inflectional marking and temporal reference. This is not the case with plurality.

To summarise, our position is that the behaviour that we observe with inflectionally complex words follows from the hypothesis that individuals with SLI lack the sub-lexical features which mark inflectional information in languages. Given that we find the same problems with plural marking and with tense marking, we cannot explain the observed behaviour through the absence or late emergence of functional projections in the syntax (cf. [42]): while tense is relevant to the determination of word order in languages, plural is usually thought not to be; thus, it is not standardly assumed to host its own projection.

In contrast to the grammatical explanation that we have provided for dysphasia, in the next sections, we turn to address three of the non-grammatical explanations that have been proposed, that SLI can be explained by low performance IQ, or by articulatory or auditory processing deficits.

4 Performance IQ

One of the criteria that has been used to delimit the clinical definition of SLI is that impaired subjects must have a performance IQ in the normal range and a language score at least 20 points lower. The reason that the performance IQ measure is included is that there is some concern that language impairments which are associated with a general pattern of cognitive impairment may be different in kind from language impairments in subjects whose other cognitive skills are not impaired. It is unclear whether this concern is well founded, but in the case of individual subjects, it is a precaution that seems warranted. The difficulty arises when this criterion is applied to members of a kindred who are similarly language impaired, but who differ in their non-linguistic IQ measures. This problem is particularly apparent in the twin studies undertaken by Bishop [37]. Bishop reports that, on occasion, one member of a pair of monozygotic twins obtained low results on non-linguistic IQ measures and thereby failed to be diagnosed as SLI because the 20 point discrepancy criterion was not met. These twin pairs could thus not be counted as concordant with respect to their problems with language even though both members of the pair exhibited significant linguistic difficulties. Bishop's findings led her to conclude that there is no substantial difference between language impaired children who have a low non-verbal IQ and those who do not.

Studies of kindreds present the same problem. If two members of a kindred are both language impaired, but one of them has a low performance IQ, then under the strict criterion for SLI, they could not be considered to have the same disorder. This would have serious effects on understanding the genetic status of this disorder. For example, we have studied an extended kindred, the K family, that is particularly interesting because of the number of individuals affected and their distribution among the families [44, 16, 17, 30, 45]. The distribution of the linguistic deficit in this family has led geneticists to conclude that an inherited factor is associated with this disorder [46]. See Figure 3.

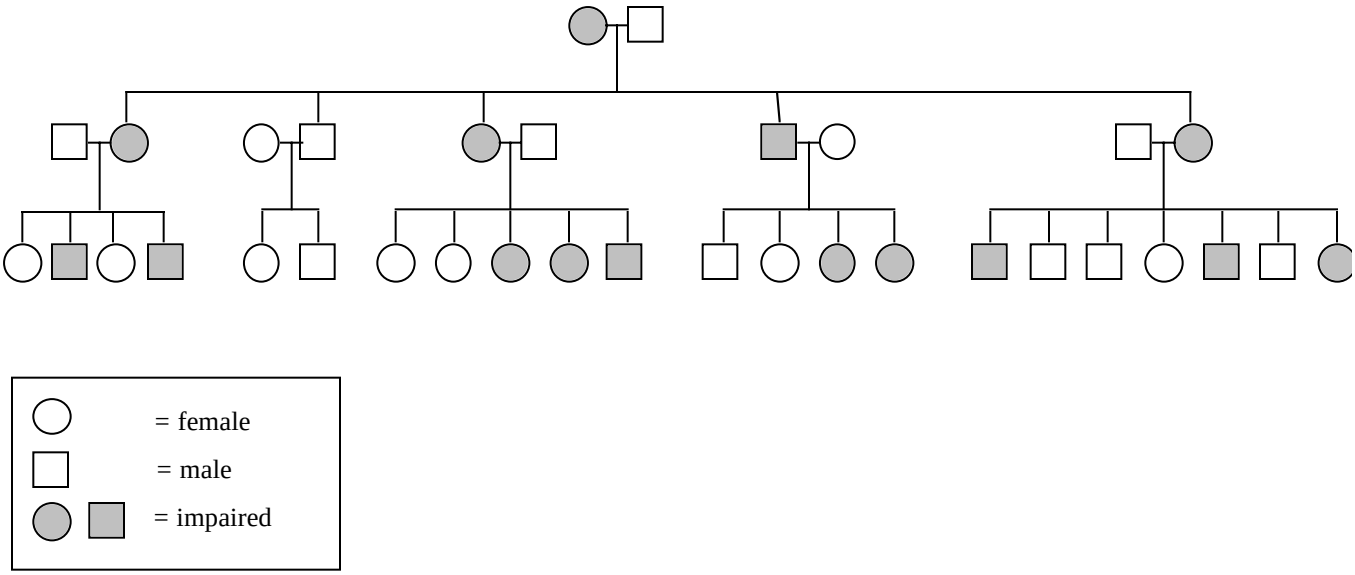


Figure 3. Family Tree of the K Family

Our interpretation of the data collected from this family as reflecting a linguistic deficit has been challenged on the grounds that some of the impaired members may have a lower performance IQ than their unimpaired relatives [11]. If this were true, this would change the genetic significance of this kindred.

The facts themselves are not absolutely clear. All of the affected third generation individuals in this family have attended a special school for language impaired children and were given standard IQ tests on numerous occasions. Our research team was given the results of the performance IQ tests for several of the language impaired members of the family and they were all within the normal range. In 1990, Hurst, Baraitser, Auger, Graham & Norell [46] report that "[h]earing and intelligence of all affected members [of the K family] were within the normal range" (p. 354). In 1992, M. Pembry, a member of the same research team, reported that "[u]sing the WAIS-R/WISC-R scales, the mean performance IQ of these 13 affected members is 95 (80-112)" (p. 54). Two years later, members of the same research group reported that subjects in this family had "a mean performance IQ of 86 (range 71-111) (compare the unaffected members' mean score of 104 (range 84-119))" [11]. In the most recent paper, the authors do not mention the earlier reports of normal intelligence or explain the discrepancy between the earlier and later performance IQ scores. Thus, the facts of the matter are not clear. Does this mean that the performance IQs of some of the impaired subjects decreased in the intervening years, or were there differences in the norms used, or in the tests used?

Even if the later report is true, the question that must be addressed is what consequence this finding has either for the interpretation of the pattern of heritability of the language disorder in this family or for the *cause* of the clearly documented linguistic deficits. If the presence of low performance IQ means that the language impaired individuals cannot be diagnosed as having the same disorder as their relatives with IQs in the normal range, then the clear pattern of inheritance seen in the family tree in Figure 3 above must be changed significantly. We would be in a situation similar to Bishop's problems with MZ twins. The mother of the first sub-family in Figure 3, who has serious problems with language, but who also has problems with arithmetic, would be

diagnosed as not having SLI. Her son, who has the same sort of language deficits, but who does not have other cognitive problems, would be diagnosed as SLI. This would require that the family tree be changed substantially and the pattern of familial aggregation of the language disorder would no longer be evident. The new report of Vargha-Khadem et al. [11] has been taken to mean that the language impairment in this family is best accounted for by their low performance IQ scores and not by a disorder in the grammar. However, even the revised numbers do not support this interpretation. The IQ scores of the language impaired subjects and their unimpaired relatives overlap substantially. One clearly language impaired subject is reported to have a performance IQ of 111, while an unimpaired relative, who has no problems with language, is reported to have a performance IQ of 84, almost 30 points lower. Although the IQ scores of the language impaired members of this family vary, they all have very similar problems with language.

The variation in performance IQ scores among members of the K family is not surprising. Clinicians commonly report that language impaired patients have widely different performance IQs, sometimes low and sometimes as high as 140. In our own research group, we have found that impaired Japanese and Greek speakers, who show similar linguistic deficit patterns to the English-speaking subjects (cf. Figures 1 and 2 above), have the same range of performance IQ scores (Japanese: 81-103; Greek: 86-111). Thus, there is no reason to believe that the range of performance IQ scores that is seen in the K family is particularly surprising. All we can conclude from this is that some individuals with high IQs have serious problems with language and some individuals with much lower IQs have no problems with language. From these facts alone, it is difficult to see how one could argue that the language disorder in the K family is *caused* by low non-verbal IQ. In order to make a causal argument, one would have to show that a particular cognitive deficit directly predicted the specific linguistic difficulties that have been documented in this population. No such argument has even been suggested.[8]

If we are on the right track about the nature of this disorder, then IQ could turn out to have some effect, but a very different one than that implied above. If impaired subjects cannot use their normal instinct for acquiring rules of inflectional morphology and, therefore, have to resort to other cognitive skills to simulate these aspects of language, then those individuals who have better general cognitive skills should be better at, for example, applying compensatory strategies which simulate unimpaired linguistic forms. Thus, while an impairment in intelligence may not *cause* the language disorder, it may affect the ability of speakers to use various strategies to compensate for the deficit. The data seem to point in this direction, but we do not yet have enough evidence to be certain.

5 Articulatory and Auditory Processing

We now turn to the other two non-grammatical explanations for GLI, that the deficit reflects a problem at the level of articulatory or auditory processing. As we have mentioned above, some language impaired individuals have surface deficits that can impede the processing and/or production of language. Leonard and his colleagues [35, 48, 49, 36] have suggested that auditory processing difficulties are responsible for the problems that have been observed in the area of inflectional morphology. The processing deficit interferes with the ability to perceive non-salient sounds, and as these sounds mark inflectional information in languages such as English, processing limitations interfere with the ability to build morphological paradigms.

The claim that inflectional morphemes in English are non-salient renders them vulnerable to deletion in production as well. The latter hypothesis is taken up in the work of Fletcher and his colleagues [25, 11]. They suggest that an articulatory processing deficit is responsible for the difficulties that individuals with GLI experience with inflectional morphology. The phonetic realisations of these morphemes in English pose an obstacle for impaired subjects as, from a production point of view, these sounds are particularly vulnerable to deletion.

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[8] In this issue, van der Lely [15] provides a detailed case study of one child with SLI which demonstrates a clear dissociation between his language impairment and his other cognitive abilities.

These two hypotheses share the claim that the problems with the overt realisation of inflectional morphology are tied to the vulnerability of the segments which express this information in English.[9] The vulnerability may be at the level of articulation or at the level of perception. Importantly, the ability to build a grammar is assumed to be unimpaired, and the problems observed stem from a performance deficit. As these two views share this central claim, we begin by discussing them together.

While we do not deny that articulatory and acoustic factors may affect the performance of impaired individuals more than that of unimpaired controls, the question that we must address is: what is the relationship between articulatory and/or auditory processing difficulties and the problems that individuals with GLI experience with grammatical morphology? If impaired processing is responsible for the difficulties found in the domain of inflectional morphology, then the following predictions should be observed in the data from dysphasic individuals:

(3) a. If the difficulties with inflectional morphology in English are tied to the vulnerability of the segments that encode this information, then vulnerable segments, specifically alveolar stops and fricatives, should be rare in the languages of the world and they should appear late in first language acquisition in unimpaired populations;

b. Inflectional morphemes which are encoded through the use of vulnerable sounds should be especially subject to deletion, while morphemes which are encoded in a more robust fashion should not be.

A further prediction is that in tasks which investigate the inflectional abilities in GLI using modalities other than audition or articulation, we should find that the performance of impaired individuals approximates that of unimpaired controls. As we have already addressed this point in Section 3.1, we will not discuss it further here.

We begin by fleshing out the auditory and articulatory processing deficit hypotheses, focussing in particular on the evidence that has been used to argue that a morpheme—or technically, the segmental content which encodes it—is non-salient or vulnerable. In the context of this discussion, we address the two points in (3) in turn, in Sections 5.1 and 5.2. We then turn in Section 6 to a more detailed discussion of the consequences of the articulatory processing deficit hypothesis proposed by Fletcher and his colleagues. Sections 7 and 8 focus on the perceptual deficit hypothesis proposed by Leonard and his colleagues.

5.1 Coronals across Languages and in Acquisition

As we have noted, both Fletcher and Leonard and their colleagues have proposed that the segmental content which encodes past and plural morphology in English is vulnerable, in production and/or in perception.[10] In this section, we argue against this view. We focus the discussion on past tense and plural, as these morphemes have been widely observed to cause impaired individuals great

[9] A third hypothesis has been proposed by Tallal and her colleagues (e.g. [50]): a temporal processing deficit that affects audition in impaired individuals underlies the difficulties they experience with inflectional morphology. Our arguments against this explanation will appear in a paper currently in preparation (see also Mody et al. [51]). Nevertheless, we mention here one relevant point. The experiments conducted by Tallal and her colleagues have been restricted to investigating the processing of voicing in stops in onset position. However, the morphology which is sensitive to voicing in English (namely, plural and past tense) is restricted to final position where the acoustic cues for voicing are entirely different. We therefore question whether this work has any bearing on the issue of the representation of inflectional morphology in English.

[10] Henceforth, we use the term 'vulnerable' to refer to material that is argued to be perceptually non-salient and/or readily subject to deletion.

difficulties.[11] Past tense and plural display the same allomorphic variation in English, and according to the discussion in Leonard [12], all three allomorphs satisfy the criteria for non-salience. Two allomorphs—[t, d] for past tense, and [s, z] for plural—are "word-final nonsyllabic consonants" [25, p. 92] which are subject to "final consonant deletion" (ibid) in the speech of unimpaired individuals.[12] The third allomorph—[ɨd] for past tense, and [ɨz] for plural—are "unstressed syllables" (ibid).

We begin with the non-syllabic allomorphs, those which are expressed by anterior coronal obstruents [t, d, s, z]. Coronals, and in particular anterior coronals, have been argued to be the *least* marked consonants cross-linguistically (see [53], inter alia). This claim is based on observations such as the following: coronals are the most commonly occurring class of segments in the world's languages, they exhibit more contrasts for place and manner than labials and dorsals, they are licensed in positions in the syllable where labials and dorsals are not, and they are the most common targets in assimilation rules. We suggest that the privileged status that anterior coronals have among the languages of the world is inconsistent with any claim about their being vulnerable. Related to this, anterior coronals are among the earliest segments to appear in first language acquisition, both in onset position and in coda (see [54] and references cited therein).

Concerning the syllabic allomorphs, [ɨd] and [ɨz], Leonard suggests that, being unstressed, they are subject to "weak syllable deletion" [12, p. 92]. However, unstressed syllables in this position are not normally subject to truncation. In the speech of normally developing English children, for example, an unstressed syllable to the *right* of a stressed syllable is not typically deleted because it can be footed; this is in contrast to an unstressed syllable to the *left* of a stressed syllable which remains unfooted in standard accounts (see e.g. [55]). Thus, syllables which appear where [ɨd] and [ɨz] do in English occupy the weak position of a trochaic foot. Given that individuals with GLI have no problem building trochaic feet [13], an appeal to weak syllable deletion to account for the difficulties that impaired speakers experience with inflectional morphology seems unmotivated.

We turn now to the salience of the plural morpheme in perception. It must be pointed out that all three allomorphs—[s], [z], or [ɨz]—contain a strident segment which is defined acoustically by high intensity noise [56, p. 42], inconsistent with any characterisation as non-salient. In a similar vein, if salience truly underlies the apparent random use of the plural and other inflections, we might expect that when they do surface, they would at least on occasion be realised in a somewhat reduced form. On the contrary, what we commonly find is productions in which saliency is *enhanced.* All of the dysphasic individuals whom we have studied have produced plurals such as [pɪtsː] where the [s] is lengthened and [bʊ́ʃɪs] where the suffix is assigned secondary stress. This observation holds both for real words and for novel words (see [16, 17]).

5.2 Nonvulnerable Morphology

The second observation raised in (3) is that inflectional morphemes which are encoded through the use of vulnerable sounds should be especially subject to deletion, while morphemes which are encoded in a more robust fashion should not be. In Sections 6 and 7, we demonstrate that this observation is not supported. We therefore reject the hypothesis that the problems that impaired individuals experience with inflectional morphology can be reduced to perceptual or articulatory processing difficulties.

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[11] Although we concentrate on past tense and plural, it should be pointed out that the same segmental content is involved in the majority of inflectional morphemes in English, third person singular agreement, genitive, and perfective for many verbs.

[12] Nevertheless, it should be pointed out that, among unimpaired speakers, deletion of coronal obstruents is much less common when these segments carry inflectional information (see [52], pp. 219-223). See further Section 6.3.2.

6 Articulatory Processing Deficit Hypothesis

To test the predictions of the articulatory processing deficit hypothesis, we focus both on the oral responses provided by the impaired subjects in experimental settings, and on their errors in spontaneous speech.

6.1 Experimental Investigations of Inflection in English

If the performance of impaired individuals on English inflections can be reduced to articulation, we should find different degrees of difficulty, dependent on the segmental and prosodic shape of an inflected form. For example, as clusters often arise through the suffixation of inflectional morphology in English (e.g. 'teased' [tijzd]), we should find a greater number of deletions in such forms as compared to forms where either the stem to which the inflection is attached is vowel-final (e.g. 'cried' [krajd]), or the stem is [t, d]-final and thereby requires epenthesis (e.g. 'waited' [wéjtɨd]). Fewer deletions are expected in the latter cases, as no new clusters arise through the addition of the inflectional morphology.

The data that we have on deletion for both past tense and plural in English are inconsistent with these predictions. There is no relationship between the segmental content or prosodic shape of a stem and the percentage of times that it appears inflected. Errors occur just as often with stems such as 'cry' as they do with stems such as 'tease'. In fact, the only difference in overt realisation of past tense and plural morphology goes in the direction opposite of what is predicted from articulatory difficulty: past-tense and plural morphology is most often absent from forms which take the allomorphs [ɨd] and [ɨz].

6.2 Suppletives

Our explanation for the difficulties that impaired individuals experience with inflectional morphology lies in the grammar. From the representations that we provided in Section 3.4 for the dysphasic grammar, we would expect to find similar difficulties with both regularly and irregularly inflected forms.[13] Further, as discussed above, we expect the absence of overt past tense marking to be independent of the segmental or prosodic shape of the stem. We can tease apart the predictions of our hypothesis and those of the articulatory processing deficit hypothesis by looking at the pattern of errors observed in suppletive verbs such as *go/went.* The past tense form *went* is so distinct from its non-past counterpart *go* that it is difficult to imagine that a subject with an intact grammar could substitute the incorrect form because of an articulatory error. Yet, such errors do occur in the spontaneous speech of the impaired members of the K family. In fact, *go* appears in 34% of temporally past contexts which require *went.* Such errors are never found in the speech of their unimpaired relatives. Thus, contrary to the predictions of the articulatory processing hypothesis, we argue that the pattern of errors observed here is consistent with the hypothesis that the problem with inflectional morphology lies in the *grammar.*

6.3 Regular Inflection in Spontaneous Speech

We turn now to regular inflection in spontaneous speech where the articulatory processing hypothesis should have some direct relevance. If the grammatical difficulties which impaired individuals have can be predicted from their articulatory problems, then we should find that these individuals have more problems than their unaffected relatives do in producing the sounds that are

[13] However, there may be differences in the presense or absence of overt marking between these two classes because of other considerations such as frequency; see Section 3.2.3.

used to mark grammatical distinctions. In English, they should have particular difficulty with final alveolar stops and fricatives, the segments which mark past tense and plural in this language. Furthermore, we would expect to find that their inability to produce the appropriate sounds correlates directly with their difficulty in producing the grammatical forms that are encoded by these sounds. We have investigated each of these predictions, paying particular attention to past tense and the segments with which it is realised in English, final alveolar stops.

6.3.1 Monomorphemic Words

If impaired individuals produce the wrong 'grammatical form' for regular past tense in English, this might be due to a problem with the grammar of tense, or it might be due to their inability to produce the appropriate segmental content which expresses regular past tense in English. It is impossible to separate out these two interpretations by looking at the productions of regular past-tense forms, because in these forms, the final [t] or [d] is a speech sound which, at the same time, corresponds to a grammatical morpheme. If, on the one hand, the problems with [t, d] are found both in monomorphemic words as well as in contexts where they serve a grammatical function, then in all likelihood, the problem is tied to articulation. If, on the other hand, the problems are restricted to contexts in which these segments have a grammatical function, then it becomes clear that the problem cannot lie in production, and must, instead, reflect a deficit in the grammar itself.

To tease apart these two possible explanations, we looked at the shape of monomorphemic words which end in alveolars in the spontaneous speech of four impaired and four unimpaired members of the K family. Samples from the subjects' spontaneous speech were transcribed and subsequently verified by an independent transcriber. As all of the subjects live in the same community, any differences which arise in their productions cannot be attributed to dialect differences.

The words which were the focus of investigation were all monomorphemic targets which end in a voiced or voiceless alveolar stop. There were three possible realisations of such words: 1. the stop is correctly produced; 2. a (reduced) consonant is substituted for the stop; or 3. the stop is deleted altogether. All three possibilities occurred for all of the subjects, both impaired and unimpaired. Regarding substitutions, a glottal stop was often produced in place of the alveolar, but this is a common phonetic substitution for stops in coda position. Similarly, [d] was on occasion realised as [t], in comformity to what is observed cross-linguistically in codas. Regarding deletion, final [t, d] were sometimes deleted before words which began with the same segment; [t] was also deleted in clusters after [s], e.g. in 'just'.

All of the impaired subjects have some articulatory problems, and thus, not surprisingly, there were some differences between the two populations in the number of substitutions that were observed. Importantly, however, there was no significant difference between the two populations in the number of deletions of final [t, d].

6.3.2 Past Tense in Spontaneous Speech

A further way in which the articulatory hypothesis was examined was through a comparison of deletion of final alveolar stops in monomorphemic words with deletion of the same segmental content when it serves a grammatical function, namely in past tense contexts. In investigating whether or not the impaired subjects overtly produced past tense in spontaneous speech, we compared surface forms which were marked for past tense with those that were unmarked. We disregarded the precise segmental and prosodic shape of the inflectional marker, for example, whether it was voiced or voiceless in appropriate contexts, and whether or not there was some sort of juncture between the stem and suffix. In other words, we counted as 'correct' those forms for which the past was overtly marked in some fashion (cf. [16, 17]).

We found a significant difference between the impaired and unimpaired subjects in the percentage of times past tense is overtly marked (cf. Table 2 above). While unimpaired speakers do

omit final alveolar stops in monomorphemic words, they virtually never omit these segments when they serve a grammatical function. This corresponds to the findings of sociolinguistic studies conducted by Labov [52]: final consonants are more readily subject to deletion when they carry no morphological content. The same observation does not hold of the speech of impaired individuals. For all but one subject, a final alveolar stop is much more likely to occur in a monomorphemic context than when it serves a grammatical function, past tense.

There are two possible explanations to capture the patterns observed in the impaired population: 1. past tense marking is assigned by rule, but the segments which mark this morphology, final alveolar stops, are deleted by a subsequent rule which selectively targets grammatical morphemes; as this process is precisely the opposite of that required for the grammars of unimpaired individuals, it is highly unlikely to be the case; or 2. verbs do not receive past tense marking because the morphological rule which assigns this information is absent from the grammar of impaired individuals; thus, they surface as (morphologically) unmarked. The latter is consistent with the grammatical deficit hypothesis outlined in Section 3.4.

6.3.3 Overregularisation

As discussed in Section 3.3.2, impaired subjects can be prompted to produce what appears to be inflectional marking on verbs and nouns. During a task where subjects were required to provide past-inflected forms for stimuli which were overtly unmarked for tense, one impaired individual consistently produced unmarked forms. In order to determine that he was indeed able to produce the final alveolar stop, several sentences with correctly-marked regular past-tense verbs were modelled for him. He was instructed to repeat the past-marked forms which he did with no difficulty. When the original test was resumed, he produced a past-like morpheme for 11 of the 12 remaining stimuli. He did not, however, produce forms that were segmentally and prosodically like those which an unimpaired speaker would produce.

Most importantly, the subject added a [t]-like form to irregular verbs which were already marked for past tense. In fact, he overinflected five of the six irregular verbs in the study (e.g. *falled, sanged*). One overinflected form was particularly interesting. He added a final [t] to a verb that was inflected for third person singular agreement. For the stimulus "Every day the wind blows. Yesterday ___", he responded with "Yesterday the wind blowst". It is highly unlikely that a form such as *blowst* could be due to an articulatory deficit. The output is clearly segmentally more complex than the correct *blew*.

When asked about his 'knowledge' of past tense marking, another male subject provided the following insight. "At school, learn it at school. In the past tense, put *e-d* on it. If it's today, it's *i-n-g* like 'swimming'. 'I went swimming today' and 'Yesterday I swamt'."

We argue that doubly-marked forms such as *blowst* and *swamt* are inconsistent with the articulatory deficit hypothesis but, instead, provide evidence for the grammatical deficit hypothesis. The latter has been disputed by Leonard and his colleagues, on grounds that the grammatical deficit hypothesis places a significant burden on rote learning of regularly inflected forms. The authors state: "Approximately 20% of the E[nglish]SLI children's errors on irregular past were overregularizations (e.g., **drawed picture*). Such errors cannot be attributed to rote learning" [36, p. 161].

Data such at these would be damaging to the grammatical deficit hypothesis if the presence of overregularisations was conclusive evidence for the existence of a rule-governed system. This, however, need not be the case. If plurals and past tense forms are stored in associative networks, a certain amount of regularisation is expected. Pinker & Prince [57] have argued precisely this for irregular verbs which display some productivity. The pattern observed for verbs such as *sing* (*sing–sung*) has been overgeneralised for some speakers to *bring* (*bring–brung*), even though *sing–sung* is stored in memory and *sung* is not generated by rule.

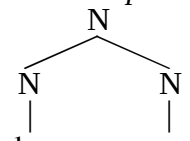
Further, we suggest that the representations provided in Section 3.4 for the GLI grammar are entirely consistent with overregularisation. Recall that we assume that the GLI grammar lacks the sub-lexical features [past] and [plural], but that the features which express lexical content are

present and unimpaired. One consequence is that there is nothing which precludes the existence of a representation for the concept of plurality (or past tense) as in (4a). The result is that there are two mechanisms with which impaired individuals can provide plurals for words that they know: they can either build them through the concatenation of lexical categories, as in [dɑgs] (without voicing assimilation) in (4b), or they can find the morphologically decomposed word as it is listed in their lexicons, as in [dɑgz] in (4c). The methodology of the Wug Test discussed earlier, where subjects are required to derive plurals from novel (and existing) forms, may favour the former route, but it is also found, although somewhat less commonly, in spontaneous speech.

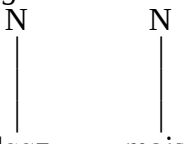
(4) a. *Lexical Status of Plural:*

Possible Representations for 'dogs' and 'mice':

b.



c.



The structures in (4b,c) predict that double marking of plural should occur, through the concatenation of the representation in (4c) with that in (4a); the result is *dogses, mices,* and the like. We thus conclude that surface 'overregularisations' do not constitute counter-evidence to the grammatical deficit hypothesis.

6.3.4 Summary

We have argued that individuals with GLI have the articulatory capacity to produce the phonetic content required to mark inflectional morphology in English. This was demonstrated by their ability to produce the relevant segments in final position in monomorphemic words. These same segments are often absent when they serve a grammatical function, a fact which we attributed to the grammatical deficit hypothesis. Second, the overregularised forms produced by the impaired subjects are often segmentally quite complex, and are most often articulatorily more difficult than the expected unimpaired outputs, e.g. *blowst* versus *blew*. We suggest that articulatory difficulty is not a factor here, and that overregularisation is exactly what is predicted under the grammatical deficit hypothesis outlined in this paper.

7 Perceptual Processing Deficit Hypothesis

In the last section, we argued that there is no evidence that morphemes which give rise to articulatorily difficult sequences are subject to deletion more than those that do not. In this section, we look at the same issue from the point of view of perceptual difficulty. As discussed earlier, the perceptual processing deficit hypothesis has been put forward by Leonard and his colleagues to account for the cross-linguistic differences observed in the overt marking of inflectional morphology in English versus Italian, for example, where this information is more robustly marked (see esp. refs [49, 36]). We present data from English and other languages which suggest that there is no correlation between perceptual salience and deletion. The cross-linguistic data are drawn from Japanese and French where we demonstrate that impaired individuals have difficulties with inflectional morphology that is marked through multisyllabic forms and through suffixes which bear stress. We conclude by providing an alternative hypothesis to account for the patterns that Leonard and his colleagues have observed in the Italian data from impaired individuals.

7.1 Are Only Non-salient Morphemes Subject to Deletion?

7.1.1 Comparatives in English

Comparatives in English provide a useful context in which to investigate the notion of salience as they are realised in two different ways, depending on the prosodic shape of the stem which they modify. Comparatives are generally expressed with the inflectional suffix *-er* when the modified adjective is monosyllabic, e.g. *big–bigger*. There is variation in bisyllabic words, depending on the segmental shape of the adjective, and to some extent, on dialect differences, e.g. *common–more common* or *common–commoner*. Words of three or more syllables are invariably modified by more in place of the inflectional suffix *-er,* e.g. *expensive–more expensive.*

If auditory processing problems are the determining factor underlying the difficulties that impaired subjects experience with inflectional morphology, then one would expect the full-vowelled CVC form *more* to be produced more readily than the unstressed suffix *-er*. The data on comparatives reported in Dalalakis [58] reveal that this is not the case. Impaired individuals in fact have more difficulty with producing and judging comparatives formed with *more* than they do those formed by suffixation of *-er*. It is very difficult to account for these data through a perceptual-processing deficit.

We hypothesise that two factors underlie the impaired subjects' better performance on the *-er* forms. One, as Dalalakis points out, *-er* comparatives are of higher frequency than *more* comparatives and are, therefore, good candidates to be stored as unanalysed chunks in the lexicons of impaired individuals. Two, all of the experimental items in Dalalakis which required the comparatives to be formed in *-er* were monosyllabic. The resulting forms are stress-initial bisyllabic words and, thus, *-er* can be incorporated into the same foot as the stem to which it is attached. The outputs are then exactly one foot, consistent with the observation of Piggott & Kessler Robb [13] that the prosodic words of impaired individuals are restricted to a maximum of one foot.

7.1.2 Crosslinguistic Evidence

We see a similar picture when we turn to data from other languages. Impaired subjects have difficulties with inflectional morphology that is encoded in a robust manner, counter to the predictions of the perceptual deficit hypothesis. In Japanese, the same patterns of behaviour are observed with tense marking as are found in English. These languages differ, however, in one crucial respect. In Japanese, tense markers are vowel-final, and many are encoded through the use of multisyllabic morphemes; for example, the probable future marker is *deshoo,* while the honorific past is *mashita.* Nevertheless, these forms are subject to deletion by impaired individuals, just as are the less salient inflectional morphemes of English (see Fukuda & Fukuda [28]).

In French, tense/aspect marking is expressed through the suffixation of morphemes which minimally contain a vowel, e.g. *il parle* [il paʁl] "he speaks" — *il parlait* [il paʁlɛ] "he was speaking". What is particularly striking about French is that stress invariably appears on the rightmost syllable. Thus, under a standard view of saliency, these morphemes, being both stressed and occurring in final position, are very salient [59]. Nevertheless, the same patterns of behaviour have been observed in French impaired individuals as in English (see Royle [29]).

These cross-linguistic findings demonstrate that saliency cannot be a major factor behind the errors that individuals with GLI make in the domain of inflectional morphology.

7.2 Inflection in Italian

We turn finally to address some properties observed in the SLI data from Italian. Leonard et al. [49] observe that while language-impaired children produce third person singular (realised in Italian by the stem-final vowel *-a, -e,* or *-o*) in 92.7% of the required contexts (SD 8.2), their success rate on third person plural (marked by *-ono* or *-ano*) is much lower, only 49.9% in required contexts

(SD 32.3). Unimpaired controls at the same mean length of utterance (MLU) are successful at producing both third person singular (93.1%; SD 12.1), and third person plural (82.3% SD 22.8). The SLI subjects most commonly produce third person singular endings in contexts that require third person plural. Although SLI children are reported to have particular difficulty with third person plural, these morphemes are more robustly marked than their substitute, third person singular. Leonard et al. remark further that the limited success that individuals with SLI display with third person plural endings is restricted to "those cases in which the verb stem plus inflection constituted only two syllables. Examples include *danno* 'they give', *fanno* 'they make', and *stanno* 'they stay', among others" [36, p. 168]. We suggest that this is related to the difficulty that impaired individuals have in building prosodic words that are larger than one foot (cf. [13]). Thus, the Italian data support the hypothesis that SLI manifests itself at the level of linguistic *representations*, both at the morphological (inflectional) level and at the prosodic level.

8 Experiments

We have seen that Leonard and his colleagues have hypothesised that a processing deficit underlies the fact that English-speaking individuals with SLI do not reliably produce inflections in appropriate contexts. Because inflectional markers in English are not acoustically salient, they are particularly taxing to perceive and thus to analyse. In Section 5, we argued that the segments which encode inflectional information in English are not low in salience; we provided evidence from the behaviour of anterior coronals across languages, both within impaired and unimpaired populations. In this section, we further discuss the notion of salience, and then report on the results of two experiments which test the consequences of this hypothesis.

8.1 What is Salience?

The auditory processing deficit hypothesis of Leonard and his colleagues involves three variables: 1. sounds that are perceptually difficult for individuals with SLI to process; 2. grammatical morphemes that are marked by these sounds; and 3. the psychological resources that are needed to construct inflectional paradigms. However, no clear and testable criteria are given to determine the role of any of these three variables independently. If we cannot decide in advance how to determine that impaired individuals have a perceptual deficit, then it is difficult to use 'perceptual deficit' as an explanatory principle. Leonard explicitly mentions that the SLI subjects he has studied do not exhibit deficits in auditory perception of the relevant segments. The same observation has been made for the language-impaired members of the K family [46, 47]. Without such an impairment, it is difficult to see how one can establish that impaired subjects have difficulty in perceptual processing—independent of the evidence from the observed pattern of morphological deficits.

Nevertheless, let us consider for the moment that impaired individuals do have a well-defined perceptual deficit. As the heart of Leonard's hypothesis is *economy:* "...although the perception of, say, [d] in *raid* may be difficult for SLI children, the acquisition of *-ed* in *played* is expected to be a greater obstacle. In the latter case, the children must not only perceive [d], they must also relate *played* to *play*, hypothesise that *-ed* is a morpheme, and place it in a word-specific paradigm" [35, p. 188]. The problem is, therefore, that the resources of impaired individuals are limited such that they cannot simultaneously process inflectional morphology and deal with the lack of saliency of the material which encodes this information at the same time.

We believe that these are independent issues. First, as we pointed out in Section 5.1, salience is an acoustic property and is thereby independent of the demands involved in analysing morphologically complex strings, a purely linguistic phenomenon. In other words, if plural [s] is difficult to perceive, then *ceteris paribus* non-morphological [s] should be similarly difficult to perceive. Second, lack of salience cannot impede production. It can only complicate perception and thereby hinder the ability to assign the correct phonetic content to abstract morphological categories during acquisition. Once the end-state grammar has been attained, salience can no longer be used to

account for the random appearance of morphological markers in production. While we do not accept Leonard et al.'s hypothesis, we do not deny that processing factors play a role in performance; however, this is independent of the ability or inability to construct grammars. In order to tease these apart, we must look beyond percentage of use in appropriate and inappropriate contexts, and focus instead on what underlies productions such as [pɪts] and [bʊ́ʃɪs] discussed earlier in Section 5.1.

Stemming from these arguments, we present the results of two phoneme discrimination tasks which contest the perceptual processing deficit hypothesis. Dysphasics perform as well as unimpaired individuals on these tasks. If their erratic behaviour on inflectional morphology were tied to difficulties in perceiving the phonetic content which marks these contrasts, their performance on phoneme discrimination should be similarly poor. We argue instead that their poor performance on grammatical tasks as compared with their excellent performance on phoneme discrimination must be due to a deeper problem, one associated with the representation of inflectional morphology in the grammar itself.

8.2 Phoneme Discrimination Tasks

The two phoneme discrimination tasks test the hypothesis that the segments which encode grammatical morphology in English are of low salience. The first experiment investigates the ability of the language impaired subjects to distinguish between pairs of monomorphemic words which differ phonetically in the same way as do stems and their past tense counterparts. To simulate regular past tense, we looked at the contrast between monomorphemic words which end in [t]/[d] and words of the same phonetic shape without the final alveolar stop, e.g. 'card' vs. 'car'. One of the well-documented problems that impaired subjects have with morphology involves distinguishing between the marked and unmarked forms of verbs. For example, they have difficulty judging that the unmarked form of a verb cannot occur in past tense contexts, that 'Yesterday the boy jump over the fence' is not grammatical in English. Importantly, the experiment reported on below did not involve the past marked forms themselves, as it would then have been impossible to determine whether the errors were the result of the subjects' inability to perceive the sound that signals the morphological distinction, or whether the errors were due to some deeper problem associated with the representation of inflectional morphemes in the grammar itself.

The second experiment tested the ability to perceive contrasts in voicing. The motivation for this experiment was twofold. First, half of the contrasts tested were [s]- vs. [z]-final nouns. These fell into three categories as follows: monomorphemic vs. monomorphemic (e.g. 'face' vs. 'phase'), monomorphemic vs. bimorphemic (e.g. 'ice' vs. 'eyes'), and bimorphemic vs. bimorphemic (e.g. 'seats' vs. 'seeds'). We could thus directly investigate the processing deficit hypothesis. The second motivation for this experiment stemmed from the observation that the impaired individuals frequently provide the voiceless allomorph of the past or plural, even for stems which end in voiced obstruents: [s] after 'crab' and [t] after 'jog' for example [16, 17, 30]. The resulting forms do not seem to involve standard phrase final devoicing.[14] It was therefore important to determine whether it could be due to the subjects' inability to perceive contrasts in voicing in final position.

Nine dysphasic individuals from the K family participated in the study. They ranged in age from 9;11 to 77;9 at the time of testing. With the exception of the oldest, all had been diagnosed as language-impaired by the school system; all had undergone or were presently undergoing therapy. There were nine age-matched controls for each test, six of whom were related to the dysphasics. Two of the six family members participated in both tasks, while the four others participated either in

[14] In fact, suffixation in these cases yields words which are highly marked—if the two obstruents are in the same syllable: there is a near universal constraint against tautosyllabic obstruent clusters disagreeing in voicing [60]. As discussed in Section 3.3.2 above, in Goad & Rebellati [36, 37], it is argued that these forms involve compounding rather than affixation; the stem and plural must therefore constitute independent prosodic domains.

the ‘Past Tense’ Task or in the Voice Discrimination Task. The ‘Past Tense’ Task was conducted during the summer of 1992, and the Voice Discrimination Task, during the summer of 1993.

8.2.1 ‘Past Tense’ Task

The discrimination tasks were similar in structure. The subjects were shown two pictures, the names for which differed on the particular dimension being investigated, in this case the presence or absence of final [t]/[d] which, when meaning-bearing, would signal past tense. One of the observations from both spontaneous speech and testing is that the language-impaired subjects make errors on irregular verbs as well as on regular verbs (cf. Sections 6.2 and 6.3.3). Therefore, for completeness, we included pairs of words which varied in their medial vowels and rhymed with the present and past forms of irregular verbs, e.g. ‘pet’ vs. ‘pot’ patterned after ‘get’ vs. ‘got’. Naturally, we did not expect errors on any of these items; however, we could use the results to measure task understanding and attentiveness.

The experimenter provided the target name for each of the pictures by saying ‘This is a toe [pointing to one of the pictures] and this is a toad [pointing to the other picture]’. In the first place, it was important to ensure that the subjects were associating the appropriate lexical item with each picture. For example, if a subject associated the word ‘frog’ with the picture instead of the intended target ‘toad’, he or she might point to ‘toe’ when asked by the experimenter to point to ‘toad’. This would fail to investigate the contrast between presence or absence of a final alveolar stop and could drastically skew the results. In addition, the dialect of the experimenter was not identical to that of the subjects. Although the dialects did not differ along any of the dimensions being investigated, it was nevertheless important to ensure that the subjects were familiar with the experimenter’s pronunciation of the stimuli.

Once the names for the two items had been provided, the experimenter asked the subject to point to one of the stimuli by saying, for example, ‘Please show me the toe’. Each item was embedded in a sentence in order to provide a natural linguistic context and, more importantly, to introduce linguistic material between the two focus items and the target. In this way, the subject could not merely phonetically match the target to the last word the experimenter had uttered, but would have to access his or her lexical representation of the target. The target item in each pair was randomly selected at the beginning of the experiment and was the same for all subjects. The first picture to which the subject pointed was counted as his or her response.

The test consisted of twenty different pairs. Twelve pairs were similar to regular verbs, e.g. ‘toe’ vs. ‘toad’. The eight others were patterned on irregular verbs, e.g. ‘pet’ vs. ‘pot’ following the model of ‘get’ vs. ‘got’. Each pair was presented twice.

None of the subjects found the task difficult. There were no errors on any of the sixteen vowel-change pairs. In addition, neither group made very many errors on the remaining twenty-four pairs which tested the presence vs. absence of final [t]/[d]: the mean correct for the nine impaired individuals was 92.6% (range: 0-3 errors out of 24), while that for the nine unimpaired individuals was 97.2% (range: 0-3 errors out of 24). A Mann-Whitney U test revealed no significant difference between the two groups ($p \geq .05$). As all of the impaired individuals, regardless of age, are able to distinguish between pairs of words that differ phonetically from one another in the same way that past tense verbs differ from their stems, we conclude that the problems with verb marking cannot be attributed to perceptual difficulties but, instead, must be due to the formal properties of inflectionally complex words.

8.2.2 Voice Discrimination Task

As mentioned above, the two discrimination tasks were similar in structure. The subjects were shown two pictures, the names for which in this case differed in the presence of a final voiced vs. voiceless obstruent. Some of the stimuli were morphologically complex and others were not. In order not to allude to their morphological make-up, the experimenter provided the name for each

picture by saying 'This picture is ice [pointing to one of the pictures] and this picture is eyes [pointing to the other picture]'. After the pictures were labelled, the experimenter asked the subject to point to the stimulus item: 'Can you point to ice?' As in the 'Past Tense' Task, the item that was requested in each pair was randomly selected and was the same for all subjects.

The test consisted of twenty-two different pairs, twelve of which were [s]/[z]-final and the remaining ten of which were not (e.g. 'buck' vs. 'bug', 'leaf' vs. 'leave'). As mentioned above, the [s]/[z]-finals were of three types: four pairs of monomorphemic vs. monomorphemic (e.g. 'face' vs. 'phase'), four of monomorphemic vs. bimorphemic (e.g. 'ice' vs. 'eyes'), and four of bimorphemic vs. bimorphemic (e.g. 'seats' vs. 'seeds').

As with the 'Past Tense' Task, none of the subjects found the task difficult. One impaired individual requested that four pairs be repeated, but nevertheless managed to achieve 100% accuracy. The mean correct for the nine dysphasics was 95.0% (range: 0-3 errors out of 22), while that for the nine unimpaired subjects was 98.0% (range: 0-2 errors out of 22). A Mann-Whitney U test revealed no significant difference between the two groups ($p \geq .05$).

To directly investigate the processing deficit hypothesis, we divided the results from the impaired subjects into two categories as follows: (a) fourteen pairs of words which were monomorphemic, whether or not they ended in [s]/[z] or in some other pair of obstruents (e.g. 'face' vs. 'phase', 'buck' vs. 'bug'); and (b) eight pairs where one or both of the words was morphologically complex, either monomorphemic vs. bimorphemic (e.g. 'ice' vs. 'eyes') or bimorphemic vs. bimorphemic (e.g. 'seats' vs. 'seeds').

The performance of the impaired subjects is unaffected by the morphological make-up of the words; monomorphemic words: 95.2% correct; morphologically complex words: 94.4% correct. Interestingly, *none* of the dysphasic individuals made any errors on the bimorphemic vs. bimorphemic pairs. These results are inconsistent with the hypothesis of Leonard and his colleagues, that individuals with SLI can produce and perceive the phonetic content which marks the various inflections in non-morphologically complex contexts, but that their processing abilities are limited such that they cannot perform the necessary morphological analysis and cope with the lack of saliency at the same time.

8.2.3 Discussion

One might contest whether we have truly tested the processing deficit hypothesis on grounds that it is not necessary for an individual to do any morphological analysis in a picture-pointing task such as the Voice Discrimination Task. However, psycholinguistic experiments on unimpaired populations reveal precisely the opposite: all types of morphological processing are automatic and unavoidable (e.g. Taft & Forster [61], et seq.). This is true even of phoneme monitoring tasks which, like the Voice Discrimination Task, could in theory be performed on the basis of phonetic content alone (see Marslen-Wilson [62, 63]). This follows directly from Leonard et al.'s hypothesis that the impairment lies in the *processing* of morphologically complex words and not in the *representation*. Our view is that the representation is impaired: inflectionally complex words are stored as morphologically unanalysed chunks, much as irregular and uninflected words are stored in the grammars of unimpaired individuals. Under this hypothesis, we correctly predict that the performance of the dysphasic individuals on the Voice Discrimination Task should be unaffected by whether or not the words to be compared are morphologically simple or complex.

To summarise, the impaired subjects have virtually no difficulty distinguishing between pairs of words which differ in the value for voicing of their final consonant, regardless of whether or not the final consonant has morphological content; nor do they have difficulty distinguishing between pairs of monomorphemic words that differ on the same dimension as do stems and their past tense counterparts. Low salience, therefore, cannot underlie the impaired subjects' problems with inflectional morphology. Their poor performance on grammatical tasks as compared with their excellent performance on phoneme discrimination must then be due to a deeper problem, one associated with the representation of inflectional morphemes in the grammar.

9 Conclusion

In this paper, we have considered four different proposals that purport to explain the difficulties that SLI subjects have experience with inflectional morphology. We have shown that the patterns of errors observed in the data are not consistent with a deficit in auditory or articulatory processing. Therefore, even if we grant that some impaired subjects have articulatory or auditory processing difficulties, these deficits cannot be the proximate *cause* of their problems with language. We have also argued that low performance IQ does not correlate with the existence of the patterns of difficulty that have been observed with language; subjects who have high performance IQ may have problems with language, and subjects who have low performance IQ may not exhibit any such problems. We therefore conclude that, while some subjects with SLI may manifest non-linguistic problems, these problems do not constitute an explanation for the language disorder.

We have focussed the discussion on inflectional morphology and, on the basis of the findings from English and from other languages, we have argued that the GLI grammar lacks the morphological (sub-lexical) features which mark inflectional information in languages. The grammar does not contain the morphological rules which introduce these features and, following from this, there cannot be structure internal to 'inflected' words. It is clear that the difficulties that impaired individuals have extend beyond the domain of inflectional morphology, both to the phonology and to the syntax. However, the existence of these other linguistic deficits does not weaken the explanatory power of grammatical deficit hypothesis that we have outlined. It remains to be seen whether all of the linguistic difficulties can be accounted for by a single deficit in the construction of the grammar.

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