Prosodic complexity and processing complexity: evidence from language impairment

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1 Introduction

Given two related speech sounds, it can usually be established on the basis of cross-linguistic comparison that one is more favoured or less marked than the other.[1] For example, a front nonround vowel can be judged less marked than a front round counterpart on the grounds that all languages have vowels of the first type whereas only some languages also have vowels of the second type.

Two widespread assumptions are often made regarding markedness and its relation to phonological representation and on-line phonological processing. First, more marked sounds are understood as being phonologically more complex than their unmarked counterparts, in the sense that they bear more feature specifications. Second, the phonological complexity of a sound stands in direct relation to the processing effort required to produce and perceive it in speech.

The link between complexity and markedness cannot be directly extended to prosodic structure. This is because we often find apparently complex syllabic or metrical structures that are actually less marked than apparently simpler counterparts. For example, although a binary branching foot is on the face of it representationally more complex than a degenerate (non-branching) foot, it is nevertheless less marked.

The link between complexity and markedness in prosody needs to be understood as being mediated by constraints on the canonical syllabic and metrical shapes of different types of morpheme. One of these constraints requires lexical heads to be prosodically heavy, that is to branch, with the result that words are minimally bimoraic or bisyllabic. What then contributes to the prosodic complexity of a word is not branchingness *per se* but rather any structure that deviates from this minimal binary shape.

Does this conception of prosodic complexity make valid predictions about degrees of complexity or difficulty in on-line phonological processing? This paper presents evidence bearing on this question. The evidence derives from an English non-word repetition experiment designed to illuminate the relative influence of syllabic and metrical complexity on phonological processing. One group of subjects had previously been identified as presenting with a grammatical type of specific language impairment. The reason for including these subjects in the study was to investigate whether a deficit in processing structural complexity in morphology and syntax might extend to prosodic phonology. As will be seen below, the results support the conclusion that metrical and syllable-internal complexity can affect repetition accuracy independently of the number of segments or syllables in a non-word.

§2 discusses the relation between prosodic complexity and constraints on canonical morpheme shape. §3 briefly reviews what is known about the phonological aspects of specific language impairment. §4 describes a non-word repetition test in which stimuli are systematically varied in ways that allow us to investigate the impact of syllabic and metrical complexity on phonological processing. The test provides the stimuli for the study that is presented in §5. §6 summarises the main conclusions.

2 Prosodic complexity and canonical morpheme shape

In segmental phonology, there is a long tradition of linking markedness with representational complexity (Trubetzkoy 1939, Chomsky & Halle 1968, *et passim*). The relative markedness of a given segment is established initially on the basis of its distribution within and across different languages. An unmarked segment is one that enjoy a wider distribution than a marked counterpart. Forging a link between markedness and representational complexity has usually been achieved by assuming that a marked segment bears more feature specifications than an unmarked counterpart (Chomsky & Halle 1968, Archangeli & Pulleyblank 1994 *et passim*).

The marked nature of more complex representational entities is often assumed to correlate with some notion of functional complexity or difficulty. For example, compared to an unmarked counterpart, a marked segment is acquired later and places a heavier burden on articulatory effort, auditory perception or phonological processing.

A moment's reflection shows that the link between complexity and markedness does not obviously carry over into the prosodic hierarchy, especially when we compare syllabic and metrical structure. For example, while a binary branching syllable onset is both more marked and more representationally complex than a non-branching onset, a binary branching foot is less marked than a degenerate foot. To put it concretely: while the two-consonant cluster in *pra* is more marked than the single consonant in *pa*, the bisyllabic foot constituted by *páta* is less marked than the monosyllabic foot *pa*.

The apparent mismatch between complexity and markedness in prosodic structure can plausibly be attributed to a strong tendency for prosodic structure to mirror morphological structure in certain ways (Inkelas & Zoll 2005, Downing 2006). The structural homology between the two domains can be understood as resulting from the action of two grammatical constraints, set out in (1) (formulated in terms based on Russell 1997, Dresher & van der Hulst 1998 and Downing 2006).

(1) (a) MORPHEME-SYLLABLE: morphemes are coextensive with syllables.
(b) HEADS BRANCH: lexical heads (roots/stems) must prosodically branch.

There is a clear cross-linguistic preference for lexical-category morphemes to be prosodically heavier than functional-category morphemes. This is expressed in the constraint HEADS BRANCH and is evidently related to the fact that lexical heads generally carry greater semantic weight. Moreover, being open-class items, they need to be phonologically more complex in order to maintain lexical distinctiveness.

Acting alone or in unison, the constraints in (1) derive the canonical prosodic shapes of different types of morphology. An affix is canonically monosyllabic (by MORPHEME-SYLLABLE) and monomoraic (i.e. non-branching). A root is also canonically monosyllabic (by MORPHEME-SYLLABLE) but bimoraic (branching, by HEADS BRANCH).

A stem (root plus affix) is minimally bisyllabic (by both MORPHEME-SYLLABLE and HEADS BRANCH).

We now have a motivation for saying that branchingness in and of itself is not enough to render a prosodic structure marked. It only counts as marked it if violates constraints on canonical morpheme shape. Take for example stems, which for our present purposes we may consider coterminous with words. Prosodic branching does not contribute to complexity when it provides a word with its minimal shape. In languages such as English, this minimal structure coincides with the stress foot. What does contribute to complexity is any structure that exceeds this minimum. For example, the word **banana** in English counts as prosodically complex under this definition. The complexity does not arise from the branching structure of the foot **nána**, since that satisfies the minimal word requirement. Rather it arises from the presence of the unstressed syllable **ba**, since the structure attaching this to the word results in the minimal shape being exceeded.

A question arises as to whether there is a correlation between prosodic complexity as defined in these terms and complexity or difficulty in phonological processing. This paper reports the results of a non-word repetition experiment that was specifically designed to answer this question. One group of subjects chosen for the study had previously been identified as presenting with specific language impairment (SLI). One of the initial motivations for including this group came from earlier studies which indicate that, compared to the developmental norm, individuals with SLI often show a deficit in processing phonologically complex forms (see the references below). However, complexity in these studies is largely calculated on the basis of the number of segments or syllables in a word, with no account taken of the kind of prosodic factors being discussed here.

In the present study, non-word stimuli were systematically varied along three prosodic parameters, three syllabic and two metrical, each of which expresses a binary opposition between an unmarked and a marked structure. The parameters are: branching versus non-branching onset; open versus closed rime; word-final vowel versus consonant; presence versus absence of a unstressed syllable left-adjoined to the word; presence versus absence of an unstressed syllable right-adjoined to the word.

3 Phonological aspects of Specific Language Impairment

SLI is a disorder of language acquisition in an otherwise typically developing child (Leonard 1998). Children with SLI are reported to have difficulty in producing and repeating polysyllabic words compared with language-matched controls (Gathercole & Baddeley 1990, Bishop *et al*. 1996, Botting & Conti-Ramsden 2001). It has been claimed that this difficulty can be attributed to a short-term memory deficit: either the capacity of the phonological store is unusually small (for example, limited to one or two syllables), or the contents of the store decay unusually rapidly (Gathercole & Baddeley 1990). Based on this hypothesis, a speech assessment tool, the Children's Test of Non-word Repetition (CNRep, Gathercole & Baddeley 1996), has been designed specifically to detect a deficit in phonological short-term memory. It is a production test in which subjects repeat non-word stimuli that are varied along a single dimension of complexity defined in terms of number of phonemes or syllables.

One drawback of CNRep is that it takes no account of the potential impact of prosodic factors on repetition accuracy (see the comments in Dollaghan *et al.*1995, Sahlen *et al.* 1999, van der Lely & Howard 1993). Moreover, it has been shown that not all children with SLI have short-term memory deficits (van der Lely & Howard 1993). This strongly suggests that other factors are in play when difficulties emerge in non-word repetition.

Consider the processing tasks involved in repeating a non-word stimulus (Snowling et al. 1991, van der Lely & Howard 1993): a phonological representation of the non-word input must be constructed; the representation must be maintained in phonological memory; the non-word must be reconstructed in speech output. In interpreting poor performance results in non-word repetition tasks, we thus need to pay very close attention to the nature of the phonological representations that are being manipulated by the subject.

The group of speakers with SLI included in the study reported on below present with a specific form of the disorder known as grammatical SLI (G-SLI), characterised as a relatively discrete, persisting core deficit in syntax and morphology (van der Lely *et al.* 1998). None of the subjects suffered from any articulation problems, and their non-verbal IQ was within normal limits (Bishop *et al.* 2000). The main purpose of the study was to investigate whether a G-SLI impairment in processing morphosyntactic complexity extends to prosodic complexity. The data for the study are drawn from a non-word repetition task known as the Test of Phonological Structure, in which stimuli are systematically varied along the five prosodic parameters outlined above.

4 Test of Phonological Structure

The major typological characteristics of syllabic and metrical structure in a given language can be described in terms of a relatively small number of binary parameters. For each parameter, one of the settings is marked relative to the other, as determined by the asymmetric distribution of the relevant structures across the world's languages. Each of the preferences revealed in these asymmetries can be expressed in terms of a unidirectional implication. For example, single-consonant onsets can be identified as unmarked on the basis of the observation that they occur in all languages, while only some languages also have consonant-cluster onsets.

Five prosodic parameters of this type feature in the Test of Phonological Structure (ToPhS, van der Lely & Harris 1999). The test assesses phonological abilities by requiring subjects to repeat non-word stimuli that are systematically varied along the three syllabic and two metrical parameters set out in Table 1. These prosodic permutations were applied to a set of four segmentally distinct base forms, each consisting of a CVCV structure with stress on the first syllable: *dɛ́pə*; *pífi*; *kɛ́tə*; *fípl*. This structure is maximally unmarked in terms of all five of the chosen parameters. The total number of -words in the ToPhS stimulus set is 128 (five binary parameters times four base forms).

The onset parameter controls whether an onset contains one consonant (unmarked) or two, e.g. *pífi* versus *prífi*. The rime parameter controls whether the stimulus has an open (unmarked) or a closed syllable, e.g. *pífi* versus *pílfi*. The word-end parameter controls whether the stimulus ends in a vowel (unmarked) or a consonant, e.g. *pífi* versus *pɪf*. (The rime and word-end parameters are typically conflated in traditional accounts of English syllable structure. However, there are good cross-linguistic reasons for keeping them separate; see Harris 1994.) Each of the stimuli contain one metrical foot, consisting either of a bimoraic monosyllable (e.g. *pɪf*) or a bisyllabic trochee (left-stressed, e.g. *pífi*). The two adjunction parameters control whether or not an unfooted (and therefore unstressed) syllable is attached to the beginning or end of this foot, e.g. *pífi* versus *sɪpífi* (left adjunction) and *pífɪtə* (right adjunction). The appearance of an unfooted syllable increases the metrical complexity of a word and is therefore the marked option.

An important design property of ToPhS is that allows the prosodic complexity of words to be manipulated independently of the number of segments or syllables they contain. For example, *dɛ́pə* is segmentally longer than *dɛp* but is prosodically less complex (per the word-end parameter). We are thus in a position to pinpoint the potential effect of prosodic complexity on test performance, independent of string complexity. This point is more fully exemplified in Table 2. This shows the varying complexity of bisyllabic non-words, which can contain anything from zero to four marked structures.

5 ToPhS non-word repetition study

5.1 Hypotheses

The ToPhS study discussed in this section draws on the much more detailed exposition presented by Gallon, Harris & van der Lely (2007). The study set out to test the following hypotheses. (i) Non-words with marked, complex prosodic structures are more difficult to repeat accurately than those with unmarked, simplex structures. (ii) The greater the number of complex prosodic structures a non-word contains, the greater will be the difficulty in repeating it accurately. (iii) Prosodic complexity influences repetition accuracy independently of string complexity.

5.2 Subjects and stimuli

The study compares three groups of children, matched according to language ability rather than chronological age. One group was composed of subjects presenting with G-SLI. The other two were composed of subjects with typically developing language (LA1, LA2). The aim of matching the G-SLI group to younger, typically developing children was to control for the effects of vocabulary and morphosyntactic abilities.

The G-SLI group was made up of 13 subjects (11 male, two female), with a mean chronological age of 15;8. Every individual in this group showed significant impairment on one or more standardised language tests. The non-verbal abilities of each individual was measured at or above average on standard IQ tests (British Ability Scales and Raven's Progressive Matrices). None showed deficits in articulation (such as dyspraxia) or psycho-social skills (such as pragmatic or attention deficits).

The language-ability control groups comprised 24 children drawn from a London primary school. These were evenly split into two age groups equally balanced by sex. All showed average verbal and non-verbal abilities as assessed by standard tests. A younger group (LA1), with an average chronological age of 5;6, was matched to the G-SLI group on the basis of morpho-syntactic ability. An older group (LA2), with an average chronological age of 7:4, was matched to the G-SLI group on the basis of vocabulary.[2]

The stimuli for the study consisted of 96 audio-recorded ToPhS non-words produced by a female native English speaker. These were presented to subjects via headphones, once each, in an uninterrupted sequence and in random order. Each stimulus was separated from the next by a three-second silent interval, during which the subject was required to repeat the non-word. Subjects' responses were audio-recorded.

5.3 Errors and scoring

Two independent coders transcribed subjects' responses, reaching 94% word-by-word agreement. The initial analysis on which the discussion below is based consisted of a simple binary classification of each response as either correct (score of 1) or incorrect (0). At this stage, no account was taken of the number and nature of errors in each response. (For a more detailed analysis of specific segmental and prosodic errors occurring in the same set of responses, see the case studies in Marshall *et al.* 2002.) However, to make the discussion below more concrete, it will be useful to look briefly at illustrations of some of the more common types of error. The examples given in (2) come from two subjects in the G-SLI group.

(2) Subject DS

	Stimulus	Response		Stimulus	Response
(a)	*dɪfrípələ*	*dɪfípələ*	(b)	*dɪfrípl*	*frípl*
	bədɛ́mpə	*fədɛ́pə*		*kɛ́stələ*	*kɛ́stə*
	dɪfímpl	*dɪfrípl*		*dɪfríp*	*dɪ̀yfríp*
				bədɛ́mpəri	*pədɛ́mbri*

(3) Subject TF

	Stimulus	Response		Stimulus	Response
(a)	*bədrɛ́pə*	*drɛ́pə*	(b)	*bədrɛ́pəri*	*dədɛ́lfri*
	dɪfípələ	*fípələ*		*bədrɛ́mpəri*	*bədrɛ́fri*
	dɛ́mpəri	*dɛ́mfri*			
(c)	*klɛ́tələ*	*čɛ́čələ*			
	sɪpífɪtə	*bə́tɪfətə*			
	dɪfrímpələ	*dɪbríčələ*			

Each of these examples contains some combination of errors involving syllabic structure, metrical structure and segmental content. Syllabic errors include the simplification of a complex onset or rime (see for example (2a) and (2b)). Metrical errors include weak syllable deletion (as in (2b) and (3a)) or refooting (evident in the introduction of a secondary stress in *dɪfríp* > *dɪ̀yfríp* in (2b)). (3b) shows a combination of syllabic and metrical errors, while (3c) shows a combination of syllabic and segmental errors.

5.4 Results

5.4.1 Overall scores. Averaged scores for each of the three subject groups are presented in Figure 1. This shows the relation between the number of correct repetitions and the number of marked/complex prosodic structures per non-word. There are significant main effects for group, prosodic complexity and an interaction between the two (all $p< 0.001$, 3x5 ANOVA). That is, prosodic complexity, as measured by the number of marked structures per non-word, has a significant influence on the performance of all groups.

As suggested in Figure 1, the most dramatic effect of complexity on performance is seen in the G-SLI group, who found the task significantly harder than the two control groups. For the G-SLI group, there is a clear decrease in the number of correct responses as the number of marked structures increases.

Planned comparisons between groups across the different degrees of prosodic complexity revealed no significant differences between LA1 and LA2. In contrast, the G-SLI group performed significantly worse than both control groups at every level of complexity. (Results derived from the Games-Howell test showed the significance of the differences between the G-SLI group and the other two groups to be: $p=0.13$ (G-SLI versus LA1 on words containing one complex structure), $p=0.001$ (G-SLI versus each of LA1 and LA2 on words with two complex structures), $p=0.000$ (G-SLI versus each of LA1 and LA2 on words with three complex structures), and $p=0.000$ (G-SLI versus each of LA1 and LA2 on words with four complex structures).

5.4.2 Syllabic versus metrical complexity. Let us now separate syllabic complexity and metrical complexity and consider their relative influence of on repetition accuracy. Figure 2 shows how the two types of complexity impact on the performance of the G-SLI and LA1 groups. An analysis by group, syllabic complexity and metrical complexity (3x4x3 ANOVA) shows significant main effects for all three factors (all $p<0.001$). There are also significant two-way interactions for group and syllabic complexity ($p<0.01$), group and metrical complexity ($p<0.001$), and syllabic and metrical complexity ($p<0.001$).

In order to investigate the interaction between syllabic and metrical complexity in more detail, a series of analyses (one-way ANOVAs) was performed to investigate what happens when (i) metrical complexity is increased while syllabic complexity is held constant and (ii) syllabic complexity is increased while metrical complexity is held constant.

First, what effect does increasing metrical complexity have at each level of syllabic complexity? When words contain no complex syllable structures, the metrical effect is significant only for the G-SLI group ($p<0.05$). With more complex syllabic structures, there are significant metrical effects for all three groups (G-SLI $p<0.001$, LA1 $p<0.05$, LA2 $p<0.05$ for one complex syllabic structure; G-SLI $p<0.001$, LA1 $p<0.01$, LA2 $p<0.05$ for two complex structures).

Now, what is the effect of increasing syllabic complexity while keeping metrical complexity constant? In the case of the G-SLI group, there are significant effects on performance at all levels of metrical complexity. For example, for words containing two marked metrical structures, there are significant differences between those containing zero versus one complex syllabic structure ($p<0.05$) and zero versus two ($p<0.001$) (though not for one versus two). In the case of the LA1 group: the only significant effect of syllabic complexity was in words marked for two metrical structures ($p<0.01$). As for LA2, the only significant effect of syllabic complexity was in words marked for zero or one metrical structure ($p<0.05$) (though inexplicably not in those marked for two).

What these two series of comparisons tell us is that increasing metrical complexity has a greater negative effect on overall performance than increasing syllabic complexity, particularly for the G-SLI group.

5.4.3 String complexity versus prosodic complexity. Let us now turn to the question of whether prosodic complexity affects repetition accuracy independently of string complexity. String complexity, recall, is based on a linear count of the number of segments or syllables in a word. Figure 3 allows to compare the proportions of correct repetitions across words with different numbers of syllables. There are significant differences based on group and number of syllables ($p<0.01$, 3x3 ANOVA). The performance of the G-SLI group deteriorates markedly as the number of syllables per word increases. On the face of it, this is consistent with a string-based definition of complexity.

However, syllable-INTERNAL complexity can also be shown to affect repetition accuracy. This is illustrated in Figure 4, where we can see what happens when syllable-internal complexity is increased while the number of syllables is held constant, in this case in monosyllabic words. There are significant main effects for group, syllabic structure and an interaction between the two (all $p<0.01$, 3x3 ANOVA).

A series of analyses (one-way ANOVAs) was performed to investigate the impact of increasing syllable-internal complexity in monosyllables within the different subject groups . The effect is significant for the G-SLI group but not for the two LA groups. In the case of the G-SLI group, there are significant differences between monosyllables marked for one versus two syllabic structures and one versus three (both $p<0.001$). Thus, for this group, syllable-internal complexity can be seen to affect repetition accuracy independently of the number of syllables in a word.

Now let us consider whether metrical complexity affects repetition accuracy independently of string complexity. In bisyllabic words containing one stress, i.e. one foot, the stress can fall either on the first syllable (the downhill pattern in for example *dɛ́pə*) or on the second (the uphill pattern in for example *bədép*). The downhill pattern is unmarked: both syllables are contained within the foot, i.e. (σ́σ). The uphill pattern is marked: only the second syllable falls within the foot, while the first syllable is adjoined to the left, i.e. σ(σ́). Since the two patterns are identical in terms of the number of syllables they contain, a string-based conception of complexity predicts that one should cause no more difficulty than the other in a repetition task. In contrast, under a prosodic account of complexity, partially footed σ(σ́) is metrically more complex than fully footed (σ́σ) and should thus be more difficult to repeat accurately.

In Figure 5, we can compare how accurately subjects repeated fully versus partially footed disyllables (the *dɛ́pə* versus *bədɛ́p* contrast). Here there are significant main effects for group, metrical structure and an interaction between the two (all $p<0.001$, 3x2 ANOVA). Planned comparisons (using the Games-Howell test) revealed that the G-SLI group performed significantly worse than the LA2 group on fully footed words ($p<0.05$) and significantly worse than both control groups on partially footed words (both $p<0.001$). There was no significant difference between the LA1 and LA2 groups under both metrical conditions. As suggested in Figure 5, the G-SLI group, unlike both control groups, repeated partially footed disyllables significantly less accurately than those with full footing ($p<0.05$, t-test). It is clear then that, at least in disyllables, metrical complexity impacts on the G-SLI group's performance independently of string complexity.

5.4.4 Error types. Most of the subjects in the G-SLI group found the ToPhS task much harder than the control subjects. The average proportion of correct responses produced by the two control groups was very high – 90% for LA1 and 93% for LA2. This is consistent with the view that prosodic structure is largely in place by three years of age (Demuth 1996). Only three individuals from the G-SLI group fell within or close to this range. Three subjects from the G-SLI group found the task especially difficult, producing scores of 31%, 36% and 41%.

The majority of repetition errors made by all groups took the form of cluster reduction in syllable onsets (e.g. *bədrɛ́pə* > *bədɛ́pə*), a process that is amply attested in younger, normally developing children. In the case of the G-SLI group, the most errors occurred in the prosodically most marked words. Table 3 shows the seven words that caused the most difficulty for this group. Each of these words contains at least three marked prosodic structures. All of them contain a complex onset. And all of them are also metrically marked, containing at least one weak syllable adjoined to the word edge. Of the 36 ToPhS words containing both a complex onset and two complex metrical structures, the G-SLI group got only half right (52%), compared to LA1 (87%) and LA2 (90%).

What is striking about the nature of the errors made by the G-SLI group in metrically complex words is that it is not the metrical structure itself that is primarily affected. Rather, the errors mainly affect syllable structure and to a lesser extent segmental content.

5.5 Discussion

The main findings of the ToPhS study presented in this section may be summarised as follows. Increasing prosodic complexity has an adverse effect on the accuracy with which subjects are able to repeat ToPhS non-words. The prosodic complexity of a word influences repetition accuracy independently of string complexity. In and of itself, marked syllable structure has little impact on repetition accuracy. The source of most repetition difficulties lies in marked metrical structure, represented in this study by weak-syllable adjunction. Metrical structure itself, however, is faithfully repeated most of the time, reflected in the relatively low incidence of weak-syllable omission. Yet it is precisely in metrically marked words that the most syllabic and segmental errors occur. That is, metrical complexity gives rise to processing difficulties at lower levels of the prosodic hierarchy.

6 Conclusion

It seems intuitively reasonable to expect that the more complex a prosodic structure is the greater will be the burden it places on phonological processing. At first sight, this expectation is confounded by the observation that branching structure is marked in some areas of the prosodic hierarchy but not others. However, to understand the relation between markedness and structural complexity in prosodic phonology, we need to take account of how much of the structure is motivated by constraints on canonical morpheme shape. Once prosodic complexity is understood in these terms, we are better placed to understand its potential impact on phonological processing.

Notes

1 University College London, 2007. Authors' UCL affiliations: Harris (Department of Phonetics and Linguistics); Gallon and van der Lely (UCL Centre for Developmental Language Disorders and Cognitive Neuroscience). The study featured in §5 of the paper is based on a much fuller presentation in Gallon, Harris & van der Lely (2007). Versions of the present paper, which is due to appear in *Revista da Associação Brasileira de Lingüística*, were presented at Miyagi Gakuin University (Sendai), UC Berkeley Linguistics Colloquium and V Congresso Internacional da Associação Brasileira de Lingüística (Belo Horizonte). Thanks to participants who provided valuable comments at each of these meetings.

2 The standardised tests used to match the G-SLI group to the control groups were: the Grammatical Closure subtest, Illinois Test of Psycholinguistic Abilities (a test of expressive morphology); the Test of Reception of Grammar (sentence understanding); the British Picture Vocabulary Scale (receptive vocabulary). For more details of the matching procedure, see Gallon *et al.* (2007).

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Table 1. The five prosodic parameters in the Test of Phonological Structure.

PARAMETER	SETTING	DESCRIPTION	REAL WORD	NON-WORD
Onset	Unmarked	No onset cluster	**city**	***pífi***
	Marked	Onset cluster	**pretty**	***prífi***
Rime	Unmarked	Open syllable	**city**	***pifi***
	Marked	Closed syllable	**filter**	***pílfi***
Word-end	Unmarked	V-final	**city**	***pífi***
	Marked	C-final	**sit**	***pif***
Left adjunction	Unmarked	Initial footed syllable	**city**	***pífi***
	Marked	Initial unfooted syllable	**banana**	***sɪpífi***
Right adjunction	Unmarked	Final footed syllable	**city**	***pífi***
	Marked	Final unfooted syllable	**Canada**	***pífɪtə***

Table 2. The relative markedness of bisyllables in the Test of Phonological Structure.

Non-word	*dɛ́pə*	*drɛ́pə*	*drɛ́mpə*	*bədrɛ́p*	*bədrɛ́mp*
Real word	**city**	**pretty**	**plenty**	**suppress**	**deflect**
Onset	0	1	1	1	1
Rime	0	0	1	0	1
Word end	0	0	0	1	1
Left adjunction	0	0	0	1	0
Right adjunction	0	0	0	0	0
Total marked	0	1	2	3	4

Table 3. ToPhS non-words with the most errors made by the G-SLI group.

Non-word	Mean % correct	N syllables	N marked prosodic structures per non-word					
			Syllabic			Metrical		Total
			Onset	Rime	Word-end	L-adj	R-adj	
dɪfrípələ	15	4	1	0	0	1	1	3
fəklɛ́tələ	15	4	1	0	0	1	1	3
fəklɛ́stələ	15	4	1	1	0	1	1	4
dɪfrímpl	23	3	1	1	0	1	0	3
dɪfrímp	23	2	1	1	1	1	0	4
fəklɛ́st	23	2	1	1	1	1	0	4
dɪfrímpələ	23	4	1	1	0	1	1	4

Figure 1. Mean % correct responses per number of marked prosodic structures per ToPhS non-word.

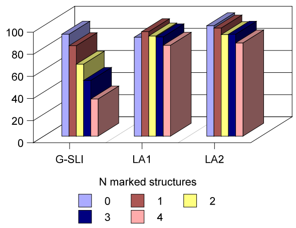
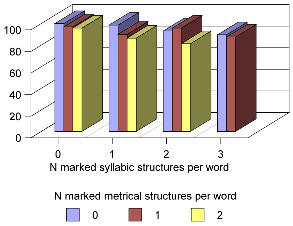
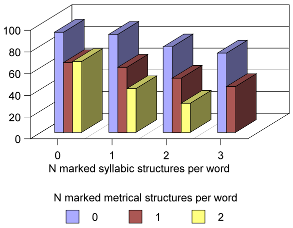


Figure 2. Mean % correct responses by number of marked metrical and syllabic structures per ToPhS non-word: G-SLI versus LA2.



LA2



G-SLI

Figure 3. Mean % correct responses by number of syllables per ToPhS non-word.

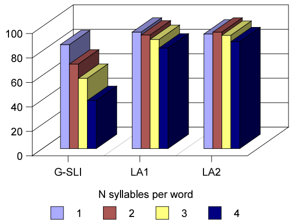


Figure 4. Mean % correct responses for monosyllabic ToPhS non-words.

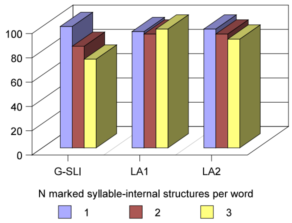


Figure 5. Mean % correct responses by metrical structure in bisyllabic ToPhS non-words.