Towards the use of phonological markedness and extraprosodicity in accounting for morphological errors in Specific Language Impairment

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Certain grammatical morphemes are variably produced in the speech of children with Specific Language Impairment (SLI). Previous research tends to view this as a consequence of either a deficit in linguistic knowledge or a limitation in processing capacity; however, both approaches raise problems. For example, linguistic accounts are unable to explain why these children's problems are mostly with production rather than comprehension. Processing accounts, on the other hand, have difficulty explaining why affected children have differing levels of problems with grammatical morphemes that are similar on the surface (e.g. English plural *-s* vs. third person singular *-s*). In this paper, a new, phonological account is proposed which avoids these problems, and better captures the wide array of data presented in the literature. It is proposed that children with SLI have problems with organizing segmental data into prosodic structures that are linguistically highly marked, in particular those that involve various forms of extraprosodicity.

Keywords: Specific Language Impairment, markedness, extraprosodicity, functional morphology, Prosodic Phonology, L1 acquisition of phonology

1. Introduction

It has long been observed that certain grammatical morphemes are variably produced in the speech of children with Specific Language Impairment (SLI) (e.g. Leonard, 2000a/2014a; Rice & Wexler, 1996; Tallal & Stark, 1981). In general terms, previous research has viewed this as an effect of either a deficit in linguistic knowledge or a limitation in processing capacity (e.g. Leonard, 2000a/2014a for a review). However, both approaches raise their own problems. For example,

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linguistic accounts have been unable to explain why most of these children's problems are with production rather than comprehension. Processing accounts, on the other hand, have had difficulty with accounting for why grammatical morphemes that are similar on the surface (e.g. English plural *-s* vs. third person singular *-s*) are produced in different amounts by affected children. Similarly, all accounts, especially linguistic ones, have had difficulty explaining certain cross-linguistic phenomena (e.g. Leonard, 2000b; Thordardottir, 2008).

In this paper, a new, phonological/prosodic approach is proposed which avoids these problems, and is able to better capture the wide array of data presented in the literature so far. The main argument is that children with SLI have problems mainly with prosody, or more specifically, with organizing segmental/morphological data into extraprosodic structures that are linguistically highly marked, and not with syntax as previous linguistic accounts have argued (although it is conceivable, given the heterogeneity of SLI, that many children have problems with other grammatical areas, as well as prosody). The argument here is not that prosody is the *only* factor involved, but that it could be a very good predictor of the problems of SLI-affected children, that could function better as a clinical marker of SLI than commonly used morphological and syntactic tools, and therefore should be given more consideration than the close to zero attention it has received in published SLI research before.

Despite the fact that there is a significant body of researchers working on prosody in atypical populations, current publication records indicate that the subject is rather underrepresented (see Setter & Stojanovic, 2013). Although the relevance of prosody and metrical information in SLI was considered as early as Gerken (1996), Gerken and McGregor (1998) and Goad (1998), and problems with prosody were accordingly identified in affected children's outputs in later research (van der Meulen, Janssen, & Den Os, 1997; Peppé & McCann, 2003; Peppé, 2009; Stojanovic & Setter, 2009), its significance was traditionally viewed mostly within the domain of prosody itself, pointing to affected children's prosodic limitations, e.g. with the correct placement of stress and intonation (e.g. Piggott & Kessler Robb, 1999). Not much has been said about the effect prosody may have on other domains of grammar (such as morphology and syntax) in impaired children, although this was raised as a possibility in recent research (e.g. Domahs, Lohmann, Moritz, & Kauschke, 2013; Kauschke, Renner, & Domahs, 2013; Marshall & van der Lely, 2007, 2009; Stojanovic & Setter, 2009). The ways in which prosodic limitations in SLI-affected children could impact other components of the grammar have not been discussed, let alone offering a theoretical means of providing a unified explanation for these limitations, perhaps with the notable exceptions of Goad (1998), where a prosodic account of English plurals in SLI is considered and eventually

rejected, and Grijzenhout & Penke (2005), where the focus was children with Broca's Aphasia learning German and Dutch.

The current work aims to fill this gap by critically evaluating the findings of earlier research that were previously attributed to morphological, syntactic, or processing-associated deficits, with a focus on English-speaking children with SLI, although we will provide extensive comparisons with children acquiring various other languages. Since the problem according to the current account is with prosody, or rather certain highly marked prosodic structures, and since prosodic constraints are generally assumed to mainly target production, problems will mostly be limited to production, and comprehension will be affected to a much lesser extent, although not completely intact, accounting for the production-perception asymmetries observed in previous research. Further, different morphological strings that are similar on the surface (such as third person singular -s vs. plural -s) will be affected differently, as the way they are prosodified is different. This account is a linguistic account in that it attributes SLI to a deficit in phonology, placing the explanatory burden on the linguistic grammar. At the same time, it has the strengths of a processing account too, in that it predicts difficulties mostly, but not solely, in production.

The remainder of this paper is organized in the following way: Section 2 provides a brief overview of the findings of previous SLI literature, focusing on the 'linguistic deficits' vs. 'processing limitations' debate, and problems previous accounts pose. Section 3 details the current account. Section 4 presents a discussion focusing on cross-linguistic facts, and demonstrates that the current account has the combined strengths of previous approaches, whether they are linguistic or processing-based, and at the same time largely achieves to avoid their weaknesses. Finally, Section 5 concludes the paper.

2. SLI and theoretical issues

SLI is a non-acquired language disorder characterized mainly by exclusionary criteria such as the absence of hearing loss, low nonverbal IQ, and severe neurological impairment (e.g. Bloom & Lahey, 1978; Leonard, 2000a; Tallal & Stark, 1981). Also called developmental dysphasia, it tends to run in families (Bishop, 2002; Gopnik, 1990; Tallal, Ross, & Curtiss, 1989). A famous example is the English-speaking KE family, where 16 out of 30 members (over three generations) were diagnosed with SLI. The family was extensively studied by a large group of researchers (e.g. Goad & Rebellati, 1994; Gopnik, 1990; Gopnik & Crago, 1991; Piggott & Kessler Robb, 1999). It was research on this family (and a comparison of the affected vs. unaffected members) that later led to the discovery of the FOXP2 gene (Lai, Fisher,

Hurst, Vargha-Khadem, & Monaco, 2001), whose mutation was found to be the cause of SLI. Further, since not all family members were impaired, linguistic environment could be ruled out as one of the primary factors in leading to SLI. A nonacquired disorder that impacts language alone, along with the finding of an associated gene responsible mostly for language and speech, is crucial in that it lends support to the generativist argument that the ability to learn language is innate, hard-wired in the brain and is largely independent of other cognitive skills.

By definition, SLI is a somewhat heterogeneous disorder (Menyuk, 1964; Leonard, 2000a/2014a, 2014b; van der Lely & Battell, 2003). Nevertheless, omitting certain grammatical morphemes, such as past tense *-ed* and third person singular *-s*, has been described as the hallmark of SLI by several researchers, irrespective of whether they view SLI as a disorder resulting from linguistic deficits or processing limitations (e.g. Gopnik & Crago, 1991; Leonard, 1989; Marchman, Wulfeck, & Ellis Weismer, 1999; Rice & Wexler, 1996; Rice, Wexler, & Cleave, 1995; van der Lely & Ullman, 2001). Cross-linguistically, error patterns of impaired children mirror those of younger, normally developing speakers of the same language at similar mean lengths of utterance (MLUs) (e.g. Kauschke et al., 2011; Leonard, 2000a, b; Thordardottir & Namazi, 2007).

Theories of SLI can largely be grouped into two: (a) those viewing SLI as an impairment caused by a linguistic deficit, and (b) those that attribute it to processing limitations. Several accounts within both theories are overviewed below (Section 2.1), with an emphasis on one popular account on each side of the debate. Problems with these accounts/theories are discussed in Section 2.2. It should be noted that all of these accounts attempt to provide a clinical marker of SLI, despite its heterogeneity.

2.1 Previous accounts of SLI

2.1.1 *Linguistic accounts*

SLI is characterized by numerous problems with morphosyntax. Thus, perhaps not surprisingly, all linguistic accounts have attributed SLI to some type of incomplete knowledge of syntactic or morphological rules or constraints.

2.1.1.1 *The Extended Optional Infinitives Account (EOIA) and its successors.* According to the EOIA (Rice & Wexler, 1996; Rice et al., 1995) the source of SLI is attributed to the underlying grammar, specifically to tense morphology. In this proposal, omitting a set of morphemes that mark tense, such as the third person singular *-s*, past tense *-ed*, *BE*, and *DO*, and (optionally) using their infinitival forms instead, serves as the clinical marker of SLI. This proposal is based on the work of Wexler (1994), who argued that young normally developing children go

through a period of optional infinitives, during which they only optionally mark tense. What makes children with SLI different from normally developing children in this approach is that they go through an *extended* period of such a stage.

In this account, children correctly mark tense; yet, they do not know that tense marking is obligatory. This is evidenced by the fact that children's errors are omission errors and not simply misplacement errors. For example, while a child with SLI (or a younger normally developing child) might omit the affix *-s* in *he eats*, when he does utter *-s*, he never uses it in an incorrect environment; that is, no sentences of the type **they eats* are uttered.

There are other types of evidence in support of this account. Perhaps the most notable of these is the finding that whereas impaired children do significantly worse than both age- and MLU-controls with third person singular *-s*, the two populations perform alike with respect to plural *-s* (Oetting, 1992; Oetting & Rice, 1993; Rice & Wexler, 1996; though see Leonard, 1989; Leonard, Bortolini, Caselli, & McGregor, 1992). Since the two morphemes are the same on the surface, these results can only be explained by referring to their different grammatical status, like the EOIA does.

The EOIA was further elaborated in an effort to capture a wider variety of errors in a greater number of languages. The Agreement/Tense Omission Model (ATOM) was proposed in order to capture the fact that although most of the errors in SLI are seemingly tense-related, e.g. *She push me*, there are also some errors of the type *Her pushed me* (although errors of this type are significantly lower in percentage). In order to account for this variation, along with more recent approaches to syntax at the time, Schütze and Wexler (1996) assumed a syntactic structure where a sentence is not only represented under the syntactic projection IP (or TP), but also AGRsP. In this account, whereas the omission of the functional node T (under TP) is responsible for an utterance like *She push me*, the lack of AGRs (under AGRsP) is the reason for an utterance like *Her pushed me*. Whereas the presence of AGRs permits the expression of the nominative case in the former example, the presence of T permits tense in the latter.

It was noted later that in several null-subject languages like Italian and Spanish, production of infinitives in place of inflected versions of verbs is not as common (Bedore & Leonard, 2001; Bortolini, Leonard, & Caselli, 1998). The Extended Unique Checking Constraint (EUCC) was later proposed to capture this observation (Wexler, 2004/2014). In this account, languages like Spanish and Italian differ from English in that they require only one checking operation, i.e. at T under TP, but not at AGRs, therefore, problems with tense and agreement will not be as common in such languages (although see Grinstead et al., 2013 for an alternative interpretation).

2.1.1.2 *The Agreement Deficit Model.* One linguistic account of SLI which is not based on the EOIA is the Agreement Deficit Model (ADM), according to which SLI involves a selective impairment in establishing agreement relationships (Clahsen, 1989). This account was later reformulated within Chomsky's (1995) *Minimalist* framework in terms of *interpretablity*. SLI, in this view, is caused by a deficit targeting the acquisition of uninterpretable features (Clahsen, Bartke, & Göllner, 1997). A broad view of this hypothesis assumed the problem to be associated with all uninterpretable features; in this view, children with SLI are predicted to have difficulties not only with third person singular -s, finite auxiliary *be*, and copula forms, but also the genitive –'s, possessive pronouns like *his* and *her*, and the nominative case. As Leonard (2014a) points out, unlike the EOIA and its successors, this account is additionally able to predict problems with the use of genitive *–'s* (based on Leonard's 1995 finding with English speaking children with SLI). However, the broad version of this account also over-predicts that children with SLI are expected to have problems with all case features and phi- and tense features of verbs and adjectives. A narrow version was later proposed in order to circumvent these issues (Clahsen, Bartke, & Göllner, 1997; Clahsen & Dalalakis, 1999; Eisenbeiss, Bartke, & Clahsen, 2006), according to which only the phi-features of verbs (and adjectives) are affected. While this account correctly pinpoints most of the errors of SLI-affected children (which are predominantly associated with verbal agreement), errors outside of subject-verb agreement are left largely unaccounted for (Leonard, Deevy, Fey, & Bredin-Oja, 2013; Lukács, Leonard, & Kas, 2010).

2.1.1.3 *The Deficit in Computational Grammatical Complexity Model (CGC).* The CGC is an extension of van der Lely's (1994) Representational Deficit for Dependent Relations (RDDR) hypothesis. In this account, what underlies SLI is a deficit in the computational system, which results in inconsistent use of certain grammatical operations, especially those that involve constituent movement (van der Lely, 1994, 1998, 2005; van der Lely & Stollwerck, 1997; van der Lely & Battell, 2003; Marinis & van der Lely, 2007). For example, a deficit involving movement from V to T leads to problems with tense, whereas a deficit targeting movement from V to AGRs causes difficulties with subject-verb agreement.

Crucially, this account was later extended to include phonology and morphology (van der Lely & Ullman, 2001), eventually taking the name CGC (Marshall & van der Lely, 2006, 2007, 2012). In this account, children with SLI have problems with structural complexity in general, including complex phonological and morphological representations, not just those in the domain of syntax. One of the best types of evidence for this account comes from the fact that English-speaking children with SLI produce regular past tense morphemes to varying degrees, depending on how complex or frequent the consonant cluster that forms the past

tense morpheme is (van der Lely & Ullman, 2001; Marshall & van der Lely, 2006; Oetting & Horohov, 1997). More specifically, comparing final English clusters such as /gd/ in words like *hugged* and /ld/ in words like *rolled*, proponents of the CGC account found that children with SLI have greater problems with the former type of clusters than the latter. This, they concluded, must be because the latter is more frequent in the input children receive, including appearing in monomorphemic words, such as *bald* or *bold*, whereas the former never appears in monomorphemic words, e.g. **bagd*, **bogd*. If children are learning past tense forms on an item-by-item basis (similar to learning irregular past tense forms), and if frequency plays a role, it is then no wonder, according to this account, that children learn forms like /gd/ later. This was taken to suggest that children with SLI use (and have problems with) declarative memory in forming past tense, instead of employing the computational system (e.g. using phonological rules) unlike normally developing children. In later research, word types that were tested were expanded upon, including past tense forms that are composed of a single final consonant (e.g. *sewed*), as well as clusters that are composed of more than two consonants (e.g. *danced*), and it was found that the more consonants the past tense suffix contains, the more challenging it is for the affected children. Further, in this line of research, phonological complexity was addressed in the same way as syntactic complexity, leading to the argument that the underlying problem with SLI is with branching constituents, such as branching codas (in phonology) or branching phrase structure (in syntax) (Marshall & van der Lely, 2007).

2.1.2 *Processing accounts*

The locus of the impairment, according to the processing accounts of SLI, is a general or specific deficit targeting processing mechanisms, which eventually impacts language development (e.g. Chiat, 2001; Gathercole & Baddeley, 1990; Joanisse & Seidenberg, 1998; Kail, 1994; Leonard, 1989). For processing accounts, SLI does not involve a deficit in a linguistic representation, but rather a deficit in information processing capacity, although the exact nature of this deficit is different depending on the hypothesis involved. Below, we cover a few of these accounts with a special focus on the Surface Hypothesis.

2.1.2.1 *The Surface Account.* One major account of SLI proposed in the literature is the Surface Hypothesis (Leonard, 1989; Leonard, McGregor, & Allen, 1992; Leonard, Eyer, Bedore, & Grela, 1997), which can be categorized under "processing" accounts of SLI (Paradis et al., 2005, among others). This hypothesis places the burden of the problem on the phonetic (i.e. surface) properties of English inflections (e.g. *-s*, *-ed*) and auxiliaries (e.g. *is*, *are*). In this account, impaired children have problems with these morphemes, because they are relatively short in

duration and thus their grammatical function is difficult to hypothesize before they disappear from the memory. This is especially true of inflectional morphemes that are composed of a single consonant or are unstressed; although lack of stress by itself is not a sufficient factor in this account, duration is (as there could be unstressed morphemes that are not short in certain positions in the sentence, e.g. the final position). In this approach, children with SLI can perceive sounds with short duration, but have difficulties with them when they play a morphological function, i.e. in production when they are separate morphemes. Accordingly, and as a result of incomplete processing, affected children will need additional input that contains these brief grammatical inflections before they are finally acquired. Other than processing limitations that are associated with brief auditory stimuli, these children are assumed, in the Surface Hypothesis, to be very much like normally developing children.

This account receives its greatest support from cross-linguistic facts. Findings from languages such as Italian (e.g. Bortolini, Caselli, & Leonard, 1997; Leonard & Eyer, 1996) and Hebrew (e.g. Dromi, Leonard, & Shteiman, 1993; Dromi, Leonard, Adam, & Zadunaisky-Ehrlich, 1999) demonstrate that relative duration is an important factor. In these languages, inflections occur in lengthened phrase final positions, and are syllabic, like the progressive *-ing* in English, which does not pose any serious problems for English-speaking children with SLI. Accordingly, impaired Italian and Hebrew children behave like MLU controls in their use of inflections, although they differ from MLU controls in free standing forms such as articles, as these are nonfinal weak syllables (Bedore & Leonard, 2001, 2005; Leonard & Bortolini, 1998).

2.1.2.2 *The morphological richness account*. The Surface Account was later extended in an effort to capture the fact that, in some languages, morphemes that are phonetically short do not necessarily pose significant problems for children with SLI (Dromi et al., 1999; Lukács, Leonard, Kas, & Pléh, 2009). It has been argued that these languages correspond to those that are morphologically richer, such as Italian and Spanish, as opposed to English, which has only a handful of inflectional morphemes.

The argument is that although SLI involves a limited processing capacity, the effects of this limitation will depend on the target language, which, if morphologically rich, requires significant devotion of children's processing resources to inflectional morphology. This means that morphologically richer languages will be advantageous for children with SLI. However, this advantage is assumed to disappear in this account if a morpheme corresponds to a great number of morphological functions (e.g. a language where tense, aspect, gender and person are all fused into one inflection), in which case processing resources available will not be

sufficient, even in learning a morphologically rich language, leading to incomplete processing and thus problems with omission and substitution. The morphological richness account is meaningful especially when evaluated within the context of the Surface Account, as it is otherwise quite narrow. Although it makes predictions regarding children's performance on inflectional morphology, it does not address other problematic morphemes, such as functional words (e.g., articles).

2.1.2.3 *The phonological memory deficits account.* One processing-based account of SLI which relies on phonological information is that of Gathercole (2006) and Gathercole and Baddeley (1990, 1993), which maintains that SLI involves a phonological storage deficit in working memory. The deficit, in this account, is more localized than that on the Surface Account, as it specifically targets phonological memory only, which, the authors argue, could be due to a number of possible underlying factors, such as initial incorrect analysis of segmental information, decay of phonological traces from memory, or a limitation in phonological storage capacity (leading to fewer items being stored, or the same number being stored but in a poorer way). This account assumes that new words are initially stored in phonological memory before entering long-term memory, and a deficit in phonological memory causes the phonological representation of these words to be imprecise, which, in turn, leads to difficulties in analyzing inflected words and eventually acquiring inflectional morphology and syntax. Evidence for this account comes especially in the form of nonword repetition tasks and serial recall of lists of spoken words, where SLI children had difficulties particularly when the word was at least three-syllable long. Impaired children's particularly pronounced difficulties in nonword repetition tasks, the proponents of the account argue, must be due to phonological short term memory, as these items, being nonwords, have not yet been stored in the lexicon, or long term memory.

2.2 Problems with previous accounts

2.2.1 *Linguistic accounts*

Despite their various strengths, all previous accounts of SLI face various weaknesses. For example, certain cross-linguistic facts cannot be straightforwardly accounted for under previous linguistic accounts of SLI such as the EOIA: If morphemes that mark tense are problematic for English-speaking children with SLI, as is argued by the EOIA, then tense-marking morphemes in other languages, such as Hebrew and Italian, should also pose problems, given that the same syntactic and morphological features are involved in these cases. Research findings indicate, however, that, in these languages, when errors are made, it is finite rather than nonfinite forms that are usually produced (e.g. Bortolini & Leonard, 1996;

Leonard & Dromi, 1994), a finding that is unexpected under the EOIA. For example, the verb in a sentence like (1), with all its tense and person inflections, was correctly produced by Hebrew-speaking children with SLI; in fact, these children were as target-like as normally developing children when it comes to the correct production of inflectional morphology.

(1) *etmol ha-yeladim raxvu*
'Yesterday, the children rode' (Leonard & Dromi, 1994: 290)

Produced errors were related to the root, i.e. /rxv/, in the form of omissions of a weak/unstressed syllable, but inflections, embodying tense, person and number, and thus including finiteness, were not omitted.

Similarly, Italian-speaking children with SLI do not generally have problems with tense-aspect morphology, correctly producing forms like those in (2a-c) (stress marks added), with the exception of third person plural, where two unstressed syllables are adjacent at the right edge (2d). In contrast, these children had extensive problems with articles (3a) and direct object clitics (3b) on the left edge (target forms are underlined).

(2) a. *véd-o*
'I see'
b. *véd-i*
'you-see'
c. *véd-e*
'He/she sees'
d. *véd-ono*
'They see' (Leonard & Bortolini, 1998: 1363)

(3) a. *Non tróvo <u>il</u> líbro*.
'I cannot locate the book'
b. *La ragázza <u>lo</u> légge*.
'The girl is reading it.' (Leonard & Bortolini, 1998: 1364)

In an effort to explain why tense and agreement inflections are not optional or problematic in null-subject languages such as Italian and Spanish, and using a Minimalist approach (Chomsky, 1995), Wexler (1998, 2004/2014) has recently expanded EOIA by proposing the Extended Unique Checking Constraint (EUCC). Accordingly, the underlying reason why tense-aspect morphology is not omitted in these languages, as opposed to languages like English, is that D features are [+interpretable] on the AgrS projection, because in these languages D features are checked only once (only against the Tense projection, not AgrS), thereby not violating the UCC. But this does not explain, as Leonard (2014a) notes, correct productions such as *she kicked me*, where both Tense and AgrS are checked,

as opposed to *she kick me* (checking only at AgrS) or *her kicked me* (checking only at Tense).

Likewise, if the problem lies in not *knowing* that tense marking (or any other syntactic or morphological construct) is obligatory, it is surprising that the only type of support for this account comes from production studies. If the problem is one of knowledge, there should be no difference, in terms of the grammaticality judgments of affected children, between a sentence like *he sees* and **he see* (see also Leonard, 2000a/2014a for a similar argument). Children with SLI should consider both equally acceptable. There is not much evidence so far showing that this is true (although see Rice, Wexler, & Redmond, 1999, where children accept sentences like **he see* and *he sees*, but not **they sees*). In fact, the problems of impaired children seem to be primarily in production; comprehension is also problematic, but to a much lesser extent.

Linguistic accounts such as the EOIA pose a logical problem as well – they are unable to present a single construct that underlies SLI, even though the search for such a construct is the very idea behind these accounts. For example, the EOIA claims that optionality in the domain of tense marking is what lies behind SLI. However, articles such as *a* and *the*, which have nothing to do with tense marking, are also among the most problematic morphemes for children with SLI. This issue receives no clear explanation under the EOIA. Although Rice and Wexler (1996) do attempt to associate determiners with tense marking, arguing that both denote the concept "reference," this stance is flawed for two reasons: First, "reference," as the authors use it, is not a syntactic or a morphological feature, though the EOIA attributes SLI to a deficit in these domains. Second, determiners as a linguistic category include not only *a* and *the*, but also demonstratives such as *this*, *that* and *those*, which also denote 'reference,' arguably more so than the indefinite article *a*. If it were indeed the case that affected children omitted "those functional categories that relate to the expression of reference" (Rice & Wexler, 1996: 1243) as the authors suggest, we would expect such demonstratives to be omitted as well. As is well known, however, this is not the case: demonstratives are used as accurately and frequently by children with SLI as MLU controls (e.g. Leonard, 2000a, Chapter 11).

Other linguistic accounts (i.e. syntactic or morphological) that hold, for example, that all functional categories are affected in SLI, cannot avoid this problem either: Although such an account would be able to include *a* and *the* as potential problem areas (together with tense marking suffixes), it would still be unable to exclude demonstratives as problematic morphemes, for demonstratives, too, are functional categories. Similarly, previous phonological accounts that are based on syllable structure complexity, e.g. the CGC, offer no principled reason as to why the simplest possible syllable, one that is composed only of a nucleus, i.e. /ə/ (the

determiner *a*) should pose any problems at all in SLI, as opposed to e.g. past tense morphology at the right edge which often leads to complex consonant clusters.

2.2.2 *Processing accounts*

As with linguistic approaches, processing-based explanations of SLI face several problems. One problem that is common to all is their failure to account for differences in omission rates of morphemes that are phonetically identical. English plural *-s* vs. third person singular *-s* is the most well-researched example of this phenomenon (e.g. Gopnik & Crago, 1991; Lahey, Liebergott, Chesnick, Menyuk, & Adams, 1992; Rice & Oetting, 1993). Previous research on these two morphemes has demonstrated that children with SLI perform much worse than MLU controls with respect to the third person singular *-s*, whereas the difference between the two groups in plural marking was either nonexistent or very small (e.g. Rice & Oetting, 1993; Oetting & Rice, 1993). There is no reason, on processing accounts like the Surface Account, why such a difference should exist, if the two morphemes are of equal length and have identical phonetic values.[1] In fact, any account that does not distinguish between the two suffixes at a level beyond the surface (e.g. the linguistic level, where the two are structurally different) will fail to capture this contrast.

The Surface Hypothesis follows Slobin's (1985) proposal that grammatical functions are hypothesized in a particular order, beginning with those that have more of a semantic content, and the use of plural -s is semantically more informative than third person singular s. Although this could potentially help account for the differences in performance regarding the two suffixes, it does so at the expense of bringing a second construct, informational content, making the argument less parsimonious.

As with linguistic accounts, cross-linguistic facts pose problems for processing accounts like the Surface Hypothesis as well. For example, not all grammatical morphemes that have short duration are problematic for children with SLI across

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1. Note, however, that Hsieh, Leonard, & Swanson (1999) found that the noun plural *-s* is significantly longer in duration in child-directed speech than is the third person *-s*, likely because it appears more often in phrase-final position where word-final fricatives are lengthened. Although this could potentially account for differences in suppliance rates between the third person singular and plural *-s*, it is unable to explain why morphemes that are longer than plural *-s*, such as the article *the* (which is composed of two sounds, instead of one), are problematic for children with SLI. Perhaps even more crucially, as the Surface Account attributes SLI-impaired children's difficulties not to perception but to production (arguing that they can perceive sounds with short duration but have difficulties with attributing a morphological function to them, see Section 2.1.2), it is not clear why longer duration associated with child-directed speech should make a difference.

languages. Clahsen and Rothweiler (1993) demonstrated that German-speaking children with SLI did as well as MLU controls in terms of obligatorily producing certain inflectional morphemes denoting past participle, irrespective of their duration. Some participles of very short duration, such as *-t*, which should have been omitted in the Surface Account, were successfully marked by these children. In cases where the Surface Hypothesis could not capture certain cross-linguistic facts, the results have been attributed to the morphological richness of the relevant language. As will be shown later, however, this reasoning is problematic too since it does not hold for every language, including most notably Mandarin-speaking children with SLI who display relatively fewer problems with aspectual morphology (see Cheung, 2009).

3. Current account

Both representational and processing-based accounts of SLI have their own strengths and weaknesses, which have been discussed in Sections 2.1 and 2.2 above. In this section, a novel account is presented, one which, I believe, has the combined strengths of the two approaches, while avoiding most of their weaknesses at the same time. Section 3.1 summarizes this proposal. Section 3.2 and 3.3 lay out the theoretical assumptions made, and Section 3.4 presents a more detailed overview focusing on cross-linguistic facts.

3.1 Phonological markedness and extraprosodicity as a clinical marker of SLI

In this paper, it is argued that the problem of SLI is that affected children do not have access to certain highly marked prosodic structures, especially those that involve extraprosodicity.[2] It is further proposed that the most marked of these, the so called *affixal clitic* and *free clitic* representations (e.g. Nespor & Vogel, 1986; Selkirk, 1980, 1986, 1995), will be the ones most problematic for affected children, and will perhaps never be fully acquired. Not every language allows these two structures, however, permitting these structures does not follow from a principle of UG. In other words, whether a language has these structures or not, and which morphemes are prosodified using these structures are *parameterized*. SLI, in this

2. See also Grijzenhout & Penke (2005) for a markedness-based account of another language disorder, Broca's Aphasia, where a prosodic explanation is, similarly, presented to account for morphological problems. However, there the emphasis is on rhymal structure, whereas the current study focuses on segmental information that is outside the Foot (and thus the syllable and the rhyme), and is, therefore, extraprosodic, linking directly to either the prosodic word or the phonological phrase (see below).

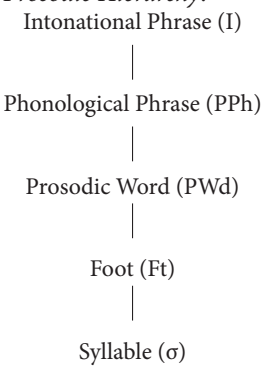
view, is the inability (or delay in the ability) to project certain marked prosodic structures. The principles of UG are thus unaffected. In other words, disordered children demonstrate behavior similar to normally developing children acquiring other languages that employ less marked prosodic structures for the grammatical morphemes involved.

Before delving more into these issues, let us view the theoretical assumptions behind this argument, which is based on the framework of Prosodic Phonology (McCarthy & Prince, 1986, 1998; Nespor & Vogel, 1986; Selkirk, 1980, 1995):

3.2 Prosodic Phonology, extraprosodicity and markedness of various prosodic structures

The position adopted here is that prosodic constituents are organized into a hierarchy, as in (4) (McCarthy & Prince, 1986, 1998; Nespor & Vogel, 1986; Selkirk, 1986, 1995):

(4) *Prosodic Hierarchy*:

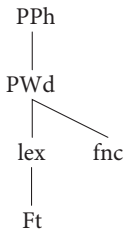


It follows from this position that sounds are organized into syllables; syllables are organized into feet; feet into prosodic words (PWds), and prosodic words into phonological phrases (PPhs), and finally, PPhs into Intonational Phrases (I). In earlier work, it was assumed that prosodic structure must abide by the Strict Layer Hypothesis (SLH) (Selkirk, 1984), which holds that each constituent is strictly dominated by the immediately higher constituent only, and is, if nonterminal, exhaustively composed of one or more of the immediately lower constituents. This entails that prosodic trees will be flat and have fixed depth (unlike syntactic trees), meaning that each syllable will be exactly two levels down from the PWd node, three from the PPh node, and so on (e.g. no multiple domination, no recursion, and no skipping of levels). More recently, researchers have acknowledged that SLH can be violated (e.g. Inkelas, 1989; Selkirk, 1995), such that constituents were no

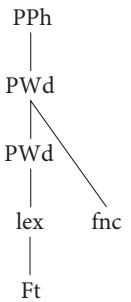
longer required to dominate constituents that are immediately lower in the hierarchy, leading to various marked constructions. Violations of SLH occur, in most cases, when (unstressed) functional morphology is involved, either in the form of inflections (e.g. English third person *-s*) or independent unstressed morphological words (e.g. English articles *a* and *the*). However, not every inflection and every function word violates the hierarchy in the same way. The nature of the violation changes from inflection to inflection, and language to language.

Details aside, according to Selkirk (1995), there are, in general, three violations (i.e. 'extraprosodic' structures on the traditional view, although Selkirk does not specifically use this term):[3] (a) certain sounds or syllables linking directly to the PWd (i.e. skipping the intermediate constituent Ft (and possibly σ) resulting in the *internal clitic* representation), (b) certain sounds or syllables linking directly to a higher PWd (i.e. *affixal clitic* representation), and (c) certain sounds or syllables linking directly to the PPh (again skipping the other constituents in between, including the PWd, resulting in the *free clitic* representation). These three representations are given respectively in (5a), (5b) and (5c).[4] Note also (5d), which is the representation where no violations of SLH are incurred. This is expected when function words are stressed, as with English demonstratives such as *this* in *this book*, which are almost always stressed in child-directed speech (since objects mentioned in child-directed speech are almost always in the immediate physical vicinity of the child). Note that in (5), functional morphology attaches to the right hand side of a word in all four representations, but their flipped versions, where functional morphology attaches to the left, are equally possible and are equally marked/unmarked as their mirror image versions (6).

(5) a. Internal clitic



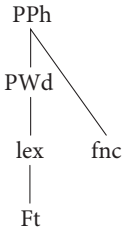
b. Affixal clitic



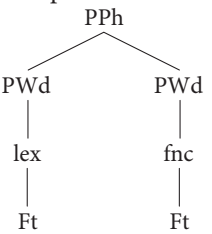
3. These are "extraprosodic" in the sense that they are positioned not inside but outside the metrical notion of Foot (the domain of stress), and sometimes outside of the PWd, too.

4. A *lexical word* (lex) is the base composed of one or more syllables (σ) under one or more feet. Syllables are excluded from the structures in (5/6) at this point for reasons of simplicity.

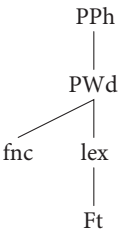
c. Free clitic



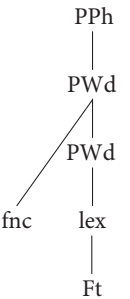
d. Independent PWd



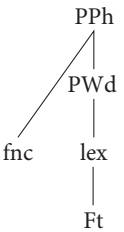
(6) a. Internal clitic



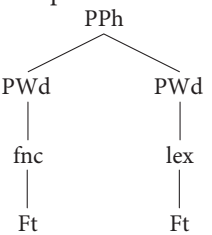
b. Affixal clitic



c. Free clitic



d. Independent PWd



Out of the four structures in (5/6), (5/6a) is the most unmarked for prosodization of unstressed functional morphemes across languages (Selkirk, 1995), and is also the one learnt earliest by normally developing children acquiring English (e.g. Demuth, 2001, 2006, 2007). Structure (5/6d) is the default structure for 'stressed' functional morphemes (and of course for nonfunctional morphemes); any child who can produce an utterance longer than one word should have no problems with this, as this is essentially the doubling of a PWd. Structures (5/6b) and (5/6c) are both highly marked. Structure (5/6b) violates the SLH on two counts: it is recursive (a PWd dominates another PWd), and not exhaustive (a PWd contains an element lower in the hierarchy than a foot). Structure (5/6c) violates the SLH because the structure is not exhaustive on two levels (the PPh contains an element two levels lower in the hierarchy than a PWd). These two structures are not found in every language. Mandarin, for example, lacks (5/6b) (Goad, White, & Steel, 2003; Goad & White, 2006, 2008), whereas Turkish lacks (5/6c) (Goad & White,

2004, 2009). Structure (5/6c) is perhaps the most marked of the two, given the facts of language acquisition in children: Child language acquisition order appears to follow this markedness hierarchy, with (5/6a) and (5/6d) learnt first, followed by (5/6b) and (5/6c) (again e.g. Demuth, 2001, 2006, 2007).

Note that in Selkirk's original approach, all these prosodic structures emerge from constraint interaction under Optimality Theory (OT) (Prince & Smolensky, 1993). A Principles and Parameters (Chomsky, 1981) version is adopted here in the interest of simplicity and clarity, as the details of an Optimality Theoretic account are not significant.[5]

3.3 Prosodic status of morphemes problematic for SLI vs. other morphemes

Functional morphemes that are problematic for children with SLI differ from unproblematic morphemes (functional or not) in that the former require one of the two most marked prosodic structures – (5/6b) or (5/6c).

It is generally assumed, in Prosodic Phonology, that English tense and agreement morphemes such as the 3rd person singular *-s* and the past tense *-ed* attach to the (base) verb as in (5b) (e.g. Selkirk, 1995; Goad et al., 2003), whereas plural *-s* attaches as in (5a) (e.g. Goad, 1998, based on Halle & Vergnaud, 1980). It is also assumed that unstressed left edge determiners such as the English articles *a* and *the* attach as in (6c) (i.e. the flipped version of (5c)) whereas stressed determiners, such as *this* and *that*, attach as in (6d) (i.e. the flipped version of (5d)) (e.g. Goad

5. Using Selkirk's OT terminology, however, (5b) and (5c) remain the most marked, as they violate a maximum number of relevant OT constraints. The relevant constraints here are EXHAUSTIVITY (i.e. No Ci immediately dominates a constituent Cj, j < i-1) and NONRECURSIVITY (No Ci dominates Cj, j = i). (5b) violates both EXHAUSTIVITY and NONRECURSIVITY: It violates the former, because a PWd immediately dominates a fnc, without the Foot constituent in between. It violates the latter, because a PWd dominates another PWd. Although (5c) violates only one of these two constraints, i.e. EXHAUSTIVITY, it violates it at least twice, or at two levels: the fnc is not immediately dominated, neither by a Foot, nor by a PWd; instead it is immediately dominated by a PPh, skipping both the Foot and the PWd, and perhaps the syllable, too, if we assume that this is only a consonant (in OT, it is sometimes more serious (or "fatal") to violate two different constraints and sometimes violating a single constraint twice could be more serious than incurring a single violation of multiple constraints.) On the other hand, (5a) violates only EXHAUSTIVITY, and only once, whereas (5d) violates neither constraint, perfectly satisfying the Strict Layer Hypothesis (Selkirk, 1984). In sum, (5b) and (5c) are the most marked structures, even if we approached the issue from the perspective of constraint violation in an Optimality Theoretic grammar. While (5d) is the least marked in the sense that it violates none of the relevant constraints as indicated here, (5a) is more unmarked because it is used more commonly for prosodification of (unstressed) functional morphology cross-linguistically.

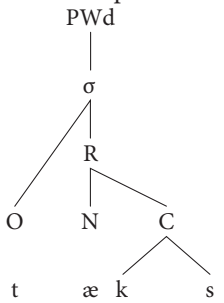
& White, 2004, 2008, 2009; Selkirk, 1995). Likewise, some function words, such as *up*, *too* and *off*, which never appear in weak forms (i.e. they always bear stress), have the status of a foot, and as a result, do not attach as prosodic clitics (but rather as full PWds; Selkirk, 1995).

Previous research presents formal evidence that both left- and right-edge functional morphology that is problematic for English-speaking children with SLI involves the marked structures in (5/6b) and (5/6c). For left-edge unstressed function words like determiners in English, the marked structures of (6b) and (6c) are, in fact, the only options. As these are never stressed (unless focused), a representation like (6d) is impossible outright, since that would require the function word to be footed. As for (6a), the internal clitic representation, Selkirk (1995) presents strong evidence that this cannot be the representation for unstressed function words: The implication of such a representation is that the *lex-fnc* combination should display behavior that is equivalent to that of a PWd that is composed of a single *lex*. It is a well-known fact, however, that at most a single unstressed syllable can occur at the left edge of a *lex* in English (McCarthy & Prince, 2001; Selkirk, 1995), as in *masságe* and *banána.* The sequence of two unstressed syllables on the left edge occurs only when a function word is available, as in /a banána/, and as such, the prosodification of words like *a* must be at least outside the lower PWd (i.e. (6a/d) are ruled out). As for why unstressed determiners should be prosodized as (6c) instead of (6b), Selkirk (1995) presents evidence from aspiration (in addition to other formal theoretical evidence); *lex-fnc* sequences such as *a c*^{h}*onversion* have an initial aspirated stop, as the stop is located in the aspiration triggering left-edge of a PWd, a position that would not be available if the PWd-initial position were occupied by the *fnc a*.

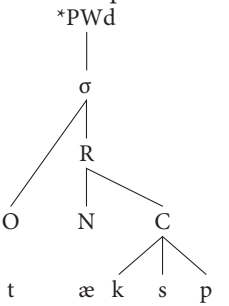
As for English tense and agreement markers, Goad et al. (2003) and Goad and White (2008) provide formal evidence that these involve the affixal clitic representation presented in (5b). Support for this comes from a comparison of English rhymes at the right edge: Rhymes of uninflected words in English (e.g. *tax*) are composed of a maximum of three positions at the right edge, i.e. nucleus + a binary coda (see (7a)); in other words, rhymes of four or more positions are not permitted in monomorphemic words (see (7b)). However, the word can accompany a fourth consonant if the relevant consonant is an inflectional tense/aspect suffix, as with the past tense morpheme in (7c) (compare with (7b)). This difference between (regularly) inflected words and monomorphemic words follows naturally from the fact that the inflectional suffix is prosodified outside of the lower PWd (and thus outside the relevant rhyme), which is why its presence is permitted in addition to the ternary rhyme of the base word/lower PWd. Compare this behavior with that of irregular past tense morphemes, which are not problematic for children with SLI (e.g. Leonard et al.,1992; Leonard et al., 1997; Oetting & Horohov, 1997). Irregulars differ from their regular counterparts in that they

undergo certain phonological changes that are not observed in the case of their regular counterparts, most notably vowel shortening (e.g. [ki:p]-[kɛp-t]), which, according to Goad et al. (2003) is evidence that these inflections attach to roots, i.e. that they are PWd-internal (see (7d)).

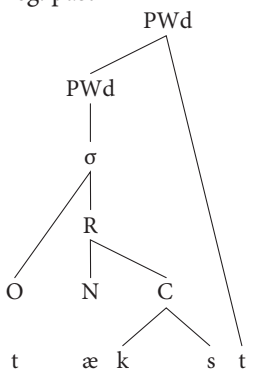
(7) a. monomorphemic



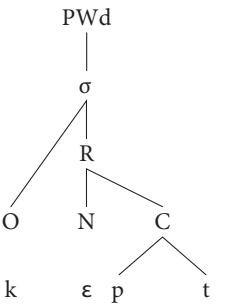
b. monomorph illicit



c. reg. past



d. irreg. past



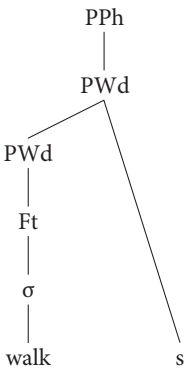
3.4 Main argument

The proposal put forward in this paper is that children with SLI have greater problems with certain functional morphemes because their grammar does not allow the prosodic structures required to correctly represent these morphemes. More specifically, these structures, i.e. (5/6b) and (5/6c), have not yet fully emerged in the grammars of children with SLI. Therefore, in the absence of being correctly prosodified in speech, these morphemes are omitted in production. However, where their grammar does allow the relevant structures (i.e. the unmarked (5/6a) and (5/6d)), children will correctly produce the corresponding morpheme. This means that children with SLI learning English will have problems with third person *-s* and past tense *-ed* (both requiring (5b)), as well as with *BE* and *DO* (both requiring (5c)) and articles (requiring (6c)). On the other hand, they will not have

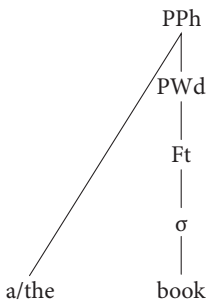
any problems with other types of functional morphology, such as stressed determiners or irregular past, since these require unmarked representations ((6d) and (7d)). Similarly, plural *-s* will not be a problem either, since it requires another unmarked structure, namely (5a). This is illustrated in (8) below with a set of English words and functional morphology.

(8) a. Internal clitic

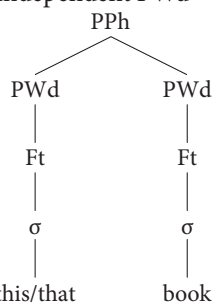
b. Affixal clitic



c. Free clitic



d. Independent PWd



Note that in this account, when pronounced/not omitted, morphemes requiring marked structures, such as the third person singular *-s* and unstressed determiners, are likely prosodified not as (5b) and (6c), but rather via the structures that are already available to the SLI-affected child. For example, (5a) or even a structure like the one provided in (7a) (which is normally for monomorphemic words) could be used instead of (5b) to prosodify a word like *(He) picks*, as these structures could also accommodate a sequence of two consonants at the right edge. In fact, evidence for this comes from van der Lely and colleagues' findings under the CGC (see Section 2.1.1.3); the more complex right edge clusters get, the more challenging the word is for the SLI-affected child (van der Lely & Ullman, 2001; Marshall & van der Lely, 2006, 2007; Oetting & Horohov, 1997). This, on the current account, is precisely because these (more) complex structures can only be accommodated through the marked structures of (5b) and (5c) (e.g. a comparison

of the licit (7c) and the illicit (7b), when there are multiple adjacent consonants), and thus cannot be reaccommodated using alternative structures.[6]

Note also that this account correctly predicts errors to be omission errors, not misrepresentation (i.e. no errors of the type *"They swim*s*" are predicted.) This is first of all because prosodic constraints are constraints mainly on production (or at least their original OT versions are assumed to be, e.g. Prince & Smolensky, 1993; Kager, 1999), although it is easy to imagine that if a speaker's grammar excludes a particular prosodic structure, that speaker will find comprehension of words that use that structure difficult, too, although perhaps not to the same extent. Crucially, since the problem in this account lies exclusively in prosody, syntax is intact. As such, no errors other than omission errors are predicted.

The predictions of the current account regarding the English functional morphology and SLI are summarized in the Table 1.

Finally note that given that not every language allows the marked representations (5/6b) and (5/6c), impaired children are not predicted to behave in the same way across languages. For example, Mandarin Chinese does not permit (5b) whereas Turkish does not permit (6c) (e.g. Goad et al., 2003; Goad & White, 2004, 2006, 2008 for the justification of this claim). In Mandarin, tense-aspect morphology is linked directly to the lower PWd, as in (5a), an unmarked structure (see

6. Note that van der Lely and colleagues present two contrasts, not one. One is between shorter and longer consonant clusters, which, as mentioned here, is captured in a straightforward manner in the current account. The other involves the disparity between clusters such as /ld/, which occur not only when an inflectional suffix is added (e.g. *yelled*), but also in monomorphemic words (e.g. *bald*), and clusters like /gd/, which never occurs in monomorphemic words (but are instead formed through inflection, e.g. *bugged*). The fact that the latter never occurs in monomorphemic words is, first of all, further evidence for the current proposal that these suffixes are prosodified not as a part of complex coda clusters, but rather as linking directly to a higher PWd. Otherwise, such sequences would not be possible in polymorphemic words, either. Second, I argue that this dichotomy stems from exactly the same type of phonological markedness considerations as those covered in this paper. Given the well-known Sonority Sequencing Principle (SSP) (e.g. Harris, 1983, among others), consonant clusters at the right edge should fall in sonority (instead of rising or being flat). Whereas the change from a liquid /l/ (which is a sonorant) to a stop /d/ involves a sonority fall, sonority remains the same for the two stop members of the cluster /gd/. Therefore, a cluster like /ld/ is more unmarked than one like /gd/, and given that English generally abides by the SSP, it follows that English-speaking children with SLI would have greater problems with the more marked cluster /gd/. To put it another way, without the ability to prosodify the past tense inflection outside the lower PWd (as in (5b)), the only option is for children to prosodify it within the lower PWd, as in (5a), but that means, for /gd/, a complex coda with falling sonority (as opposed to the case with /ld/), meaning that it is more marked and is thus more likely to be omitted.

Table 1. Prosodic structures and the corresponding morphemes predicted to be problematic for English-speaking children with SLI

	Not problematic for SLI	**Problematic for SLI**
Structures involved	5a, 5d, 6a, 6d (unmarked)	5b, 5c, 6b, 6c (marked)
Corresponding morphemes	stressed determiners, plural *-s*, irregular past, monomorphemic words, strong function words (e.g. *up, too, off*)	Third person singular *-s*, regular past tense, unstressed determiners, *BE*, *DO*, greater difficulties with ternary clusters

Goad & White, 2006).[7] The current proposal therefore predicts that a Mandarin-acquiring child with SLI should not have significant problems with tense-aspect morphology. This is, in fact, confirmed by the findings of recent research: Cheung (2009) found that impaired Mandarin acquirers did not have problems with any of the four aspect markers of Mandarin. This is true despite the fact that Mandarin has very few tense-aspect morphemes. In fact, Cheung argues that Mandarin has no markers for tense (for the same argument, see also Huang, 1982; Li, 1985; Tang, 1990), and has only four markers for aspect (those that he investigated). Thus, accounts based on morphological richness cannot capture the success of Mandarin speakers with SLI (more on this in the next section).[8]

Like Chinese, there are data from many other languages that provide additional evidence for the current proposal, although the same data are rather challenging for previous accounts of SLI. The following section will address such cross-linguistic issues.

7. In a series of papers on the errors of Mandarin and Turkish-speaking learners of L2 English, Goad and White argue that Mandarin-speaking L2 learners of English omit English tense inflections much more often than other types of inflections, precisely because (5b), the prosodic structure required for tense/aspect morphemes in English, is not available in Mandarin. Conversely, Turkish-speaking L2 learners of English omit English articles (but not tense morphemes), because the structure (6c), which is required in English for prosodification of determiners, is not available in Turkish. I assume that, as with L2 learners, these (marked) structures emerge later in the grammars of children with SLI, as the input required for the emergence of adjunction structures like (8b), i.e. a sequence of two consonants at the right edge, is ambiguous with the input required for PWd-internal representations like (7a/d) (see also Goad and White for the same argument for L2 speakers). Only with greater exposure to words that end in three consonants, such as (7c), can the learner possibly add the affixal clitic representation in their grammar.

8. It should be noted, however, that in a well-controlled study by Fletcher, Leonard, Wong, & Stokes (2005) on Cantonese, a language closely related and similar to Mandarin, children with SLI used both perfective and imperfective aspect markers in fewer probe sentences than both younger and age-matched controls.

4. Further discussion and cross-linguistic evidence

A comparison of the current account (see Section 3) with its predecessors (see Section 2) indicates that the current account has the combined strengths of both linguistic and processing accounts, while avoiding most of their problems. For example, just like the linguistic EOIA account (and unlike the Surface Account), it can successfully predict different results with respect to impaired children's command of plural *-s* vs. third person singular *-s* in English, even though the two types of morphemes look alike on the surface – third person singular *-s* will be problematic, because it requires the structure (8b), which (together with (8c)) is absent (or has not yet fully developed) in the grammars of children with SLI. Similarly, since prosodic constraints mainly target production, the current account correctly predicts errors to be mostly in production, instead of comprehension, just like the Surface Hypothesis (and unlike the EOIA).

Cross-linguistically as well, the Extraprosodicity account proposed here has the necessary predictive power, predicting cases other accounts fail to predict, as well as avoiding over-prediction at the same time, thereby ruling out patterns that do not receive empirical support. This is not true of previous accounts of SLI, all of which over-predict and are not as restrictive. For example, the EOIA predicts tense-related morphemes to be problematic in every language, and this prediction does not receive empirical support, as with Italian and Hebrew (Section 2.2.1). This is not a problem on the current account however, because in this account morphemes like the third person singular *-s* and past tense *-ed* are problematic in English not because they are related to tense, but rather because they have the prosodic representation of an affixal clitic ((5b) and (8b)), which is unavailable to children with SLI. Accordingly, since this representation is not utilized by every language (i.e. some languages prosodify their functional morphology differently), lacking it will not necessarily be a problem for impaired speakers of those languages, or at least, it will not lead to omission errors on the surface in those languages.

Just as the EOIA over-predicts in expecting tense-related morphology to be problematic cross-linguistically, the Surface Hypothesis over-predicts in expecting morphemes with short duration to be problematic across languages. As was explained above (Section 2.2.2), this is not necessarily the case (e.g. Clahsen & Rothweiler, 1993 for German). Some studies attribute this to morphological richness, arguing that fewer omissions will occur in morphologically richer languages, and this seems to be supported by findings on languages like Hebrew, Icelandic and Italian (e.g. Bortolini et al., 1997; Dromi et al., 1999; Leonard et al., 1997 for Italian and Hebrew, and Thordardottir, 2008 for Icelandic). However, an account based on morphological richness fails to capture why Mandarin-speaking children with SLI have no problems with aspectual morphology (Cheung, 2009), even

though Mandarin is by no means a morphologically rich language (a textbook example of an isolating language, it only has a handful of suffixes).

The current account, although it is a restrictive hypothesis, is also able to capture research findings that have previously been attributed to rich morphology, e.g. data from Hebrew, Italian, Spanish and Icelandic. In fact, these cases receive a rather straightforward explanation in the current account. Both Icelandic and Italian, trochaic languages like English (Hayes, 1995), allow word-final degenerate feet,[9] unlike English (e.g. Árnason, 1985 for Icelandic; Nespor, 1993 for Italian). Allowing final degenerate feet means, for these languages, the existence of sequences with an odd number of syllables that are stressed on their final syllable (usually secondary stress), e.g. SWS or SWSWS (SWW or SWSWW for most English words).[10] This means that the final syllable in these languages is always footed, either as the only syllable within a degenerate foot, and thus the head of the foot (in words with an odd number of syllables) or in the dependent (unstressed) position of the final trochaic foot (in words with an even number of syllables). Crucially, as final syllables (whether stressed or not) are necessarily footed in these languages, they have to be within the base PWd, and so cannot be linked extraprosodically to the PWd as in (5b) and (5c) above; this, in turn, suggests that SLI-affected learners of these languages will not have any serious problems with inflectional morphology at the right edge. After all, they do not (often) have to utilize the marked representations (5b) and (5c) to correctly prosodify right-edge functional morphology. This, then, accounts for the findings of previous research for Icelandic and Italian. Additional evidence for this comes from the one Italian tense-aspect morpheme that *is* problematic in SLI, the third person plural form of

9. A degenerate foot, in a trochaic language, means a single strong syllable following a sequence of strong and weak syllables (i.e. "(SW)(S)" or "(S)(SW)") depending on the value of an additional prosodic parameter, i.e. Directionality of foot construction: If Directionality is Left-to-Right, it results in a final strong syllable as with [(SW)(S)]; if, on the other hand, it is Right-to-Left, it results in an initial strong syllable, as with [(S)(SW)] (see Hayes, 1995 for more on prosodic parameters such as Directionality). English does not allow degenerate feet, and as such, certain syllables in odd numbered words are left unfooted. In fact, such unfooted syllables have been demonstrated to be omitted more often than their footed counterparts (Gerken, 1996; Gerken & McGregor, 1998), as predicted by the current account.

10. This is a very simplified explanation. Such factors as Weight Sensitivity also play a role in reality, meaning that a heavy syllable in weight-sensitive languages like English can form a foot by itself without having to create a degenerate foot (as a heavy syllable in a weight-sensitive language is binary at the moraic level, morae being constituents of Prosodic Hierarchy below the syllable). Even so, English words are almost never finally stressed, because Extrametricality is set to *Yes* in English, and as such, word-final syllables are (almost) never visible as concerns foot construction or stress. The reader is referred to Dresher and Kaye (1990) and Hayes (1995) for an overview of these parameters and the interaction between them.

present tense (see 2d). This problematic morpheme is the only one with a sequence of two unstressed syllables at the right edge, suggesting that the rightmost syllable must be extrametrical, i.e. [(vé.do).<no>], as opposed to e.g. [(vé.de)].

The explanation for Hebrew-speaking children with SLI is even more straightforward. In Hebrew, most words are stressed on their final syllable (Bat-El, 1993; Becker, 2003), which means that the final syllable is within a foot and is thus necessarily within the base PWd. This is true also of the inflectional morphology in the sentences used in research with Hebrew-speaking children with SLI. To illustrate, the stress pattern of the words in (1) above, an example used in Leonard and Dromi (1994), is provided below in (9):

(9) *etmól ha-jeladím ʁaχvú* (Michael Becker, p.c.)
Yesterday the children ride.PAST
'Yesterday, the children rode'.

As seen, inflectional morphology is in the strong position of the verb, the position that bears main stress, and is thus necessarily footed, regardless of the exact type/nature of this foot. So, similarly to Italian and Icelandic, normally developing speakers of such languages will not utilize (5b) and (5c) at the right edge, meaning that impaired children's (universal) problems with such structures will not be revealed on the surface (since they do not have to utilize these structures).

A question that naturally follows from this discussion is whether this proposal predicts that finally stressed languages will necessarily not pose problems on the right-edge for children with SLI. The answer to this question is in the positive. Evidence comes from the study of children acquiring languages like French, in which stress is regularly word/phrase final (e.g. Charette, 1991; Scullen, 1997). Findings of studies with impaired French-speaking children demonstrate that these children do not have difficulties with right-edge functional morphology; rather, their difficulties lie at the left edge, particularly in the domain of determiners and object clitics (e.g. Thordardottir & Namazi, 2007; Hamann, 2004; Jakubowicz & Nash, 2001; Maillart & Schelstraete, 2003). For example, Thordardottir and Namazi (2007) found almost perfect performance on noun-related inflections and about 95% on verbal inflections (see (10)) in the speech of children with SLI, comparable to their MLU-matched French-speaking controls. For determiners and, in particular, object clitics (which appear in the non-salient pre-verbal position), on the other hand, there are much greater difficulties; Hamann (2004) reports almost complete omission (less than 10% correct) of object clitics in some SLI-affected children, and Paradis, Crago, and Genesee (2003) refer to this pattern as a clinical marker of SLI in French. Compare (10) with (11); whereas the tense and agreement markers in (10), which appear as suffixes at the right edge, occur in the prominent phonological phrase-final position, and are mostly produced in the

speech of children with SLI, object clitics, such as *la* in (11), appear unstressed in a phonologically non-salient (pre-verbal) position, and are mostly omitted in SLI.

(10) aim-es (love-2SG), aim-ons (love-1PL), aim-ent (love-3PL)
(Hamann, 2004: 121)

(11) *Brigitte la mange.*
Brigitte DO.CLI:FEM eat.PRES
'Brigitte is eating it' (Paradis et al., 2003: 639)

This difference is predicted in the current account, because determiners and left-edge clitics in French are prosodified as in (6c) (i.e. the free clitic representation; Goad & Buckley, 2006; Tremblay & Demuth, 2007). In fact, given Selkirk (1995), (6c) and (6b) are the only options in which unstressed determiners and left edge clitics are prosodified in languages across the world, and both of these are hypothesized, in the current account, to be problematic structures, for children with SLI. In sum, the current account provides a principled explanation not only for why the right edge is not problematic for French-speaking children with SLI, but also why the left edge differs in this regard, a dichotomy that is not predicted by any of the previous accounts of SLI.

A similar dichotomy is observed with Spanish-speaking children with SLI. Whereas right edge inflectional morphology does not create any problems for these children, functional words at the left edge pose significant problems (e.g. Bedore & Leonard, 2001, 2005; Bortolini, Caselli, & Leonard, 1997; Bortolini, et al., 1998). Bedore and Leonard (2001), for example, found that, for grammatical morphemes such as the 1st person singular present and past and 3rd person singular present and past, as well as others like these that denote tense and person, children with SLI had an accuracy rate of about 80% or more (similar to MLU controls), whereas, for articles (definite or indefinite) and direct object clitics, their accuracy rate fell to about 46% and 38% respectively (significantly lower than MLU controls). That is, they were much more accurate for inflectional verbal morphology at the right edge as in (12) than left edge determiners and clitics, exemplified in (13a) and (13b) respectively (parts in parentheses were what children were expected to produce in their experiments; target items are underlined).

(12) *Los niños barren y el papá (<u>corta</u> el pasto)*
'The children sweep, and the dad (cuts the grass).'
(Bedore & Leonard, 2001: 924)

(13) a. *Aquí hay una zanahoría y aquí hay (<u>unos</u> huesos). El conejo come la zanahoría y el perro come (<u>los</u> huesos).*
'Here's a carrot and here's (some bones). The rabbit eats the carrot and the dog eats (the bones).'

b. *El niño compra el helado y luego (lo come).*
'The boy buys the ice cream and then he (eats it).'
(Bedore & Leonard, 2001: 924)

In fact, Spanish-speaking children have been found to behave very similarly to MLU-matched peers with regard to all right edge inflectional morphology, with the notable exception of the noun plural *-s* (Bedore & Leonard, 2001; Leonard, 2014a). Neither this general observation regarding the behavior of Spanish-speaking children with SLI nor the exception to it involving the plural marker is a mystery in the current account: Spanish has a very well-documented prosodic system. Formal phonological research has shown that whereas determiners in this language are affixal clitics (Harris, 1989; Demuth, 2007), as in (6b), right edge functional morphology is organized within the PWd (Alers-Valentín, 2000; Morales, 2014; Nuñez Cedeño & Morales-Font, 1999), as in (5a). As such, and given the current proposal, only left edge function words are expected to pose problems in SLI. An examination of the Spanish stress system is also informative in this regard: Exceptions aside, whereas consonant-final words are stressed on the (heavy) final syllable (e.g. *comér* 'to eat'), vowel-final words bear stress on the penultimate syllable (e.g. *náda* 'nothing') (Hualde, 2005). This is a typical weight-sensitive right-to-left trochaic system (Hayes, 1995), where final syllables are necessarily footed, i.e. [co.(mer)] and [(na.da)]. If all final syllables are footed, they will naturally not adjoin to the PWd; rather, they will be under the foot that heads the PWd, thereby avoiding the marked prosodic structures of (5b) and (5c). An exception to this pattern is words that end in the consonants /s/ and /n/; when a word ends with one of these consonants, stress is penultimate, just like vowel-final words (e.g. *éstas* 'to be'). The most standard explanation for this exception is that /s/ and /n/ are extrametrical, i.e. that they are ignored for the purpose of stress assignment (so words ending in these consonants behave as if they were vowel-final regarding stress assignment), and thus, that these consonants are not represented within a foot. Given this, it is only natural for the Spanish plural marker, which is *-s*, to constitute the one exception to the generalization that Spanish-speaking children with SLI do not have problems with right edge inflectional morphology.

The dichotomy observed in SLI between left and right edge morphology could, perhaps, be best illustrated through data from Swedish-speaking children with SLI. Swedish has an interesting article system; whereas indefinite articles precede the noun they are associated with, definite articles are bound morphemes attached after the noun, as illustrated in (14).

(14) a. *en sak*
'a thing'
b. *sak-en*
'the thing'

It was found that whereas Swedish-speaking children with SLI do worse than MLU controls in their use of indefinite articles like those in (14a), they are as good as typically developing children with respect to the use of the definite article (14b) (Hansson, Nettelbladt, & Leonard, 2003). Such a finding is surprising under virtually any other linguistic or processing account, because the two morphemes are nearly identical both phonetically and in terms of the linguistic function they serve (both denoting articles/reference). On the current account, however, this phenomenon receives a natural explanation. Similar to Hebrew, Icelandic, Italian and especially Spanish, material at the right edge is always footed in Swedish, and is, therefore, not extraprosodic. Evidence for this comes from Swedish, where final syllables, when heavy, are stressed (Frid, 2001). However, when the final syllable is light and the penult is heavy, the penult is stressed. This suggests a weight-sensitive system where final syllables always appear in a foot. Compare this with the English examples *lábyrinth, génesis, aspáragus, appéndix, agénda, Màssachúsetts, Mìnneápolis*, etc., where, unlike in Swedish, heavy final syllables are not stressed, as they are extrametrical, e.g. [(géne)<sis>]. When the final syllable is absolutely within a foot, as with Swedish and unlike in English, it will not link directly to the PWd (as it will be within a foot, which heads the PWd if stressed), thereby avoiding the marked adjunction structures.

Another striking dichotomy between two affixes that are otherwise similar involves the present and past tense suffixes in Turkish, both of which are attached at the right edge (since with almost all affixes in Turkish), but differ with regard to their prosodic behavior, as well as their status for children with SLI. Recent research with Turkish-speaking children with SLI has revealed that these children have much greater problems with past tense (see (15a)) than present tense (see (15b)) (Yarbay Duman, & Topbas, 2016).

(15) a. *Adam süt-ü- iç-ti.*
man milk-ACC drink-PAST
'The man has drunk/drank milk.'
b. *Adam süt-ü- iç-iyor.*
man milk-ACC drink-PRES.
'The man is drinking the milk.' (Yarbay Duman, & Topbas, 2016, p. 4)

This finding may look surprising at first, as both suffixes have similar functions, both denoting tense, one for the present, the other for the past.[11] Looking into the prosodies of the two suffixes is, however, rather informative on the issue: whereas the past tense suffix *-di* is a so-called 'regular' suffix in that it bears regular/final (intonational) prominence and is thus not footed (as with the great majority of Turkish suffixes), the (present) continuous suffix *-iyor* is different precisely in that it is a 'stressed exceptional' suffix, and is, as such, exceptionally footed (Özçelik, 2014, 2017 for a discussion of how only a handful of suffixes, including the present tense suffix, are footed in Turkish). In sum, whereas the unfooted past tense suffix is challenging for children with SLI, the footed present tense suffix is not, a finding that follows directly from the predictions of the current proposal.

The cross-linguistic predictions of the current account, and the theoretical assumptions behind them, are summarized in (16).

(16) Summary of cross-linguistic predictions under the Extraprosodicity account of SLI
   a. Left edge functional morphology, such as articles, is usually prosodified using the marked structures (6b) and (6c) cross-linguistically. Thus, left edge functional morphology will generally pose problems for SLI-affected children across languages, unless stressed (as with stressed determiners in English), in which case they employ the unmarked (6d), and will not cause problems.
   b. Right edge functional morphology, such as tense, aspect and person markers, is prosodified in a variety of different ways depending on the language. Unlike English, many languages do not employ the marked structures (5b) and (5c) in prosodifying right edge functional morphology, and such languages will not be problematic, at the right edge, for SLI-affected children. In order to pinpoint such languages, one needs to find out whether words affixed with functional morphology behave phonologically like monomorphemic words, as with Mandarin. In general, one straightforward and efficient way of predicting which languages prosodify right edge functional material in ways different from (5b) and (5c) is to look into whether functional morphemes at the right edge are linked directly to the base PWd. The following cues help predict such languages:
      i. A finally-stressed language will necessarily have final syllables footed, and functional morphemes at the right edge will thus necessarily be within a foot, which heads the PWd, and

11. It should be noted, however, that although the sentence with *-iyor* denotes present continuous tense, the suffix *-iyor* itself is the marker for continuous aspect, and is, unlike *-di*, not a tense marker (e.g. Kornfilt, 1997).

can therefore not be outside of the base PWd. Examples: French and Hebrew.

ii. A language may not have (consistent) final (primary or secondary) stress, but may still have all final syllables footed, as with:
   – languages with weight-sensitive right-to-left trochaic footing in which the final syllable is stressed if heavy, otherwise the penult. Examples: Spanish and Swedish
   – languages that have a degenerate foot at the right edge (typically after left-to-right footing). Examples: Icelandic and Italian

iii. Certain languages are, in the general case, footless. In some of these languages, there is exceptional footing (which comes as part of the underlying representation of morphemes), leading to an expected dichotomy with respect to the performance of SLI-affected children's performance on footed vs. footless suffixes, even if the two suffixes attach to the same edge. Example: Turkish

All things considered, the Extraprosodicity-based account presented here is a restrictive hypothesis that has the combined strengths of previous accounts and avoids their weaknesses, too. It offers a principled reason, using a single construct, as to why both articles and certain (but not all) inflectional morphemes should be problematic for English speaking children with SLI, whereas only the former should be problematic for impaired speakers of languages like Chinese, French, Hebrew, Icelandic, and Italian. In doing so, it also accounts for forms that have previously been dismissed as exceptions, whose explanation follows directly from the proposal made here.

5. Conclusion

In this paper, a novel phonological account of SLI was proposed within the framework of Prosodic Phonology. This account holds that morphemes that require a highly marked extraprosodic structure (i.e. structures (5/6b) and (5/6c) above) will often be omitted in production by children with SLI, because these children, who are delayed in their acquisition of prosody, have not yet fully acquired these structures. Normally developing children, too, go through similar steps in acquiring their native language prosody, and they learn the problematic (5/6b) and (5/6c) structures much later than less problematic structures such as (5/6d), where morphemes have no extraprosodic status, and (5/6a), where they have a less marked status. This is in line with the general finding in the SLI literature that error patterns of children with SLI mirror those of younger, normally developing speakers of the same language (Thordardottir & Namazi, 2007; Leonard, 2000a, b).

This is an hypothesis which is testable and falsifiable; different predictions will arise given that different languages prosodify functional material differently. It should also be noted, however, that although a very strong case was made in this paper for Extraprosodicity as a clinical marker of SLI, SLI is a very heterogeneous condition, and it is highly likely that affected children display other grammatical and processing-based deficits alongside prosodic ones. It is not, by any means, claimed here that prosody is the *only* factor underlying SLI-affected children's problems. It is, however, argued that prosody plays a much greater role than previously attributed to it, and that it is potentially a better predictor of SLI-affected children's difficulties than other linguistic accounts such as the syntax-based EOAI and processing-based accounts such as the Surface Hypothesis. More research, involving the prosodic systems of languages that are hitherto uninvestigated in SLI literature, needs to be conducted in order to test the applicability of the idea in additional languages and structures.

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Résumé

Certains morphèmes grammaticaux sont produits de façon variable dans le parler des enfants souffrant de dysphasie. En général, ce phénomène a été traité dans les recherches antérieures comme le produit ou d'un manque de connaissances linguistiques ou d'une limitation de la capacité de traitement. Ces deux approches entraînent des problèmes. Par exemple, les approches linguistiques sont incapables d'expliquer pourquoi les problèmes de ces enfants sont plutôt des problèmes de production que de compréhension. Les approches basées sur le traitement, par contre, ont des difficultés à expliquer pourquoi les enfants ainsi affectés rencontrent divers niveaux de difficulté avec des morphèmes grammaticaux qui se ressemblent superficiellement (p. ex.: le *-s* pluriel et le *-s* de la troisième personne du singulier en anglais). Cette étude propose une nouvelle approche phonologique qui évite ces problèmes et qui semble mieux appréhender l'éventail varié des données présentes dans la littérature. On propose que les enfants souffrant de dysphasie rencontrent des problèmes d'organisation des données segmentées en structures extra-prosodiques qui manifestent un niveau élevé de marque linguistique.