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On the nature and cause of Specific Language Impairment: A view from sentence processing and infant research

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ABSTRACT

This paper addresses the nature and cause of Specific Language Impairment (SLI) by reviewing recent research in sentence processing of children with SLI compared to typically developing (TD) children and research in infant speech perception. These studies have revealed that children with SLI are sensitive to syntactic, semantic, and real-world information, but do not show sensitivity to grammatical morphemes with low phonetic saliency, and they show longer reaction times than age-matched controls. TD children from the age of 4 show trace reactivation, but some children with SLI fail to show this effect, which resembles the pattern of adults and TD children with low working memory. Finally, findings from the German Language Development (GLAD) Project have revealed that a group of children at risk for SLI had a history of an auditory delay and impaired processing of prosodic information in the first months of their life, which is not detectable later in life. Although this is a single project that needs to be replicated with a larger group of children, it provides preliminary support for accounts of SLI which make an explicit link between an early deficit in the processing of phonology and later language deficits, and the *Computational Complexity Hypothesis* that argues that the language deficit in children with SLI lies in difficulties integrating different types of information at the interfaces.

1. Introduction

In the last 20 years there has been a wealth of studies on the language abilities of children with Specific Language Impairment (SLI) across different ages and languages (Leonard, 1998). This was motivated mainly by two reasons. First, from a clinical perspective, research on SLI was necessary to establish how this disorder manifests itself, and to provide evidence for the nature and cause of the impairment. This could have clinical implications for differential diagnosis, prevention, and treatment. The second reason is related to linguistic theory. SLI was of particular interest because the existence of a disorder affecting language but supposedly not other cognitive domains seemed to provide empirical evidence for modularity.

The majority of studies on children with SLI have investigated language production and comprehension by using off-line methods. These have provided invaluable information about the language strengths and weaknesses of this group of children, and have led to the formulation of several hypotheses to account for the nature and cause of the impairment. However, our knowledge about the nature and the cause of SLI still remains incomplete. This is because of the nature of the group, the limitations of the designs and methodologies used so far and also the fact that none of the existing theories can account for the profile of the children. The present paper addresses the nature and cause of SLI by reviewing research in language processing in children and in infant speech perception, which can bring new insight into the nature and cause of

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SLI. Section 2 introduces key characteristics of SLI based on off-line studies, Section 3 presents the most important current accounts that have been put forward to explain the nature and cause of SLI, and Section 4 reviews studies on sentence processing in children with SLI. Section 5 discusses the relation between language acquisition and language processing and presents results from the German Language Development (GLAD) Project that provides evidence for a link between an early auditory delay and impaired processing of prosodic information and later language deficits in children with SLI. Section 6 pulls everything together by critically discussing the accounts presented in Section 3 in relation to the results from the sentence processing studies in Section 4 and the findings from the GLAD project in Section 5.

2. The phenotype of children with SLI based on off-line studies

Children with SLI are a heterogeneous group of language impaired children. The heterogeneity results from the way they are classified. Their inclusion in this group is not based on the aetiology of the impairment, because this is still unknown, but on a mismatch in their language vs. other cognitive abilities. Children with a language impairment but performance within the norms in non-verbal cognitive tasks are classified as children with SLI. This includes children who differ very much from each other. Some have difficulties only in production, others only in comprehension, and others in both production and comprehension. The hallmark of SLI seems to be problems in the production and comprehension of morpho-syntax. These manifest themselves in different ways depending on the language the children are acquiring. For example, English children with SLI have more problems in the verbal domain (tense/agreement) (Rice and Wexler, 1996) compared to the nominal domain (articles, plural marking) (Bedore and Leonard, 1998); in their production they omit to a greater extend the regular past tense *–ed* morpheme, auxiliaries, copulas, and the 3rd person singular *–s* morpheme compared to articles *a/the* and the noun plural *–s* morpheme. In contrast, Greek children with SLI have difficulties in both the verbal and nominal domain. In the verbal domain, deficits have been reported in the production of subject–verb agreement and to a smaller extend in the production of past tense (Clahsen and Dalalakis, 1999; Mastropavlou, 2006; Smith, 2008). In the nominal domain, Greek children with SLI have persistent difficulties in the production of accusative and genitive clitic object pronouns, genitive marking on definite articles and to a smaller extend definite articles (Mastropavlou, 2006; Smith, 2008; Tsimpli, 2001; Tsimpli and Stavrakaki, 1999).[1]

The problems children with SLI have are not restricted to the domain of morpho-syntax. Several studies have revealed that children with SLI show phonological problems, have problems in vocabulary acquisition, and show deficits in the syntax-semantics/pragmatics interface. In the domain of phonology, children with SLI show a delay in the acquisition of consonants, and have difficulties in the production of consonant clusters. Early acquired consonants are acquired later in children with SLI, and later acquired consonants cause difficulties even in school-aged children with SLI. Complex syllable structures, such as CCV, are often simplified as CV (Bortolini and Leonard, 2000; Leonard, 1982; Orsolini et al., 2001). In terms of vocabulary acquisition, children with SLI are late in acquiring their first words, and at the early stages of development they use more words to describe objects, substances and animals than actions and properties (Leonard et al., 1982). Pre-school children with SLI seem to use a more limited variety of verbs than language controls, and these tend to be of high frequency (Watkins et al., 1993). Children with SLI have been reported to have problems in naming pictures; they are slower in naming (Lahey and Edwards, 1996), and they make more phonological and semantic errors than their age-peers (Lahey and Edwards, 1999). Of particular interest are studies looking at lexical learning using fast mapping tasks because this can provide a window in the process of word learning. These studies have shown quantitative and qualitative differences between children with SLI, age, and language controls. Differences are less pronounced when the task involves names for unfamiliar objects (Dollaghan, 1987), and are more pronounced when the task involves names for actions and the presentation is in continuous speech, which means that children are not presented with the novel word in isolation, but have to abstract it from the input stream (Rice et al., 1990). Children with SLI also show a slower learning rate than typically developing (TD) children (Windfuhr et al., 2002). A further factor that seems to impact on lexical learning is the number of exposures to the novel words. Children with SLI require a larger number of exposures to the novel words than TD children, and are not as good as TD children in maintaining novel words in long-term memory, particularly verbs (Rice et al., 1994). Finally, several recent studies have shown deficits in the syntax-semantics/pragmatics interface, such as universal quantification, telicity, definiteness, and exhaustivity in wh-questions (Roeper, 2004; Schulz and Roeper, 2011; Schulz and Wittek, 2003).

Apart from problems in morpho-syntax, phonology, vocabulary, and syntax-semantics/pragmatics interface, a large number of studies have shown that children with SLI score lower than age- and language-matched TD children in tasks tapping phonological memory, such as non-word repetition and sentence repetition (Botting and Conti-Ramsden, 2001; Gathercole, 2006; Gathercole and Baddeley, 1990), and suggests that children with SLI have a deficit in phonological memory. In addition, a growing number of studies have revealed that children with SLI process linguistic but also non-linguistic information at a slower rate than TD children (Miller et al., 2001). Furthermore, many studies have shown that some children with SLI also have deficits in non-linguistic abilities, such as motor skills (Hill, 2001) and symbolic play (Johnston, 1994).

Finally, it is crucial to keep in mind that children with SLI are a heterogeneous group of children. The deficits mentioned above are not shared by all children with SLI. This has led to the identification of several subgroups of children with SLI. For example, Conti-Ramsden and Botting (1999) have classified children with SLI in six different subgroups: (1) children with a

[1] For an overview of comprehension problems in children with SLI, see Bishop (1997) and Leonard (1998).