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Lexical activation during sentence comprehension in adolescents with history of Specific Language Impairment

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ABSTRACT

One remarkable characteristic of speech comprehension in typically developing (TD) children and adults is the speed with which the listener can integrate information across multiple lexical items to anticipate upcoming referents. Although children with Specific Language Impairment (SLI) show lexical deficits (Sheng & McGregor, 2010) and slower speed of processing (Leonard et al., 2007), relatively little is known about how these deficits manifest in real-time sentence comprehension. In this study, we examine lexical activation in the comprehension of simple transitive sentences in adolescents with a history of SLI and age-matched, TD peers. Participants listened to sentences that consisted of the form, Article-Agent-Action-Article-Theme, (e.g., *The pirate chases the ship*) while viewing pictures of four objects that varied in their relationship to the Agent and Action of the sentence (e.g., Target, Agent-Related, Action-Related, and Unrelated). Adolescents with SLI were as fast as their TD peers to fixate on the sentence's final item (the Target) but differed in their post-action onset visual fixations to the Action-Related item. Additional exploratory analyses of the spatial distribution of their visual fixations revealed that the SLI group had a qualitatively different pattern of fixations to object images than did the control group. The findings indicate that adolescents with SLI integrate lexical information across words to anticipate likely or expected meanings with the same relative fluency and speed as do their TD peers. However, the failure of the SLI group to show increased fixations to Action-Related items after the onset of the action suggests lexical integration deficits that result in failure to consider alternate sentence interpretations.

Learning outcomes: As a result of this paper, the reader will be able to describe several benefits of using eye-tracking methods to study populations with language disorders. They should also recognize several potential explanations for lexical deficits in SLI, including possible reduced speed of processing, and degraded lexical representations. Finally, they should recall the main outcomes of this study, including that adolescents with SLI show different *timing* and *location* of eye-fixations while interpreting sentences than their age-matched peers.

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1. Introduction

Successful spoken communication depends on the listener's ability to rapidly interpret and integrate the meaning of multiple words as a sentence unfolds. For the listener to succeed at this task, many aspects of lexical processing must be coordinated simultaneously. For instance, listeners must segment and decode the rapidly decaying acoustic signal into words. They also must activate and/or retrieve the correct lexical information from semantic memory and then hold onto the accumulating information as the sentence unfolds. In typically developing (TD) children and adults, these abilities interact rapidly to allow listeners to update their understanding of ongoing sentences continuously and to generate expectations about upcoming lexical items within the sentence. Children with Specific Language Impairment (SLI) have significant difficulty with many of these underlying lexical processing skills. In this study, we explore how adolescents with a history of SLI integrate meaning across multiple spoken words to comprehend sentence in real time, using a visual world eye-tracking paradigm.

The term *Specific Language Impairment*, introduced by Stark and Tallal (1981), refers to a diagnosis in children who have difficulty acquiring and using language in the absence of any clear etiology (e.g., hearing loss, intellectual impairment, neurological involvement). Language difficulties in these children include delayed onset and slower acquisition of lexical and grammatical forms, smaller vocabularies, and difficulty acquiring and using inflectional morphology and complex syntax (Leonard, 1998). Children with SLI have a multitude of linguistic and non-linguistic deficits, including difficulties in understanding words and sentences. Although there are several competing accounts of the etiology of SLI, there is a growing body of work that suggests that the language deficits seen in SLI are secondary to impaired nonverbal cognitive processing factors, such as speed of information processing and/or working memory capacity (e.g. Ellis Weismer, Evans, & Hesketh, 1999; Gillam, Cowan, & Marler, 1998; Hoffman & Gillam, 2004; Leonard et al., 2007; Montgomery & Evans, 2009; Montgomery, 2000a, 2000b). These domain-general accounts of SLI contrast with other proposals that characterize language deficits in (at least some groups of) children with SLI as domain-specific, arising primarily from a specific difficulty with acquisition or usage of grammatical aspects of language, such as tense marking, verb agreement, object clitics, or more hierarchically structured grammatical forms (Clahsen, Bartke, & Göllner, 1997; Paradis, Crago, & Genesee, 2006; Rice, Wexler, & Cleave, 1995; van der Lely, 2005).

While much of the research in SLI has focused on morpho-syntactic deficits, lexical abilities are compromised as well (Alt & Plante, 2006; Alt, Plante, & Creusere, 2004; Capone & McGregor, 2005; Lahey & Edwards, 1999; Leonard, Nippold, Kail, & Hale, 1983; McGregor & Appel, 2002; McGregor, Newman, Reilly, & Capone, 2002; McGregor & Waxman, 1998; Seiger-Gardner & Schwartz, 2008). For example, in novel-word learning studies, children with SLI require more exposure trials to link novel words to meaning as compared to typical peers (Alt & Plante, 2006; Alt et al., 2004; Gray, 2003, 2004; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, & Bode, 1994). They also have significant difficulty learning the semantic features of novel words and appear to attend to qualitatively different semantic features of novel objects as compared to their TD peers (Alt & Plante, 2006; Alt et al., 2004). Further, it appears that the semantic/conceptual representations of children with SLI are poorly differentiated, which results in weaker activation or priming of semantic associations between highly familiar lexical items as compared to typical children (Lahey & Edwards, 1999; Mainela-Arnold, Evans, & Coady, 2010a, 2010b; McGregor, 1997; Sheng & McGregor, 2010).

Children with SLI are also slower and less accurate than are their TD peers across a range of lexical processing tasks involving known items, including lexical decision tasks (Crosbie, Howard, & Dodd, 2004; Edwards & Lahey, 1996; Windsor & Hwang, 1999) and rapid automatic picture naming (Edwards & Lahey, 1996; Lahey & Edwards, 1999; Leonard et al., 1983). In gated lexical identification tasks, children with SLI require more time than do their TD peers to identify known words in isolation (Mainela-Arnold, Evans, & Coady, 2008; Marshall & van der Lely, 2008). Finally, children with SLI are also slower than their typical peers to identify and retrieve the meanings of words embedded in ongoing sentences (Montgomery, 2002, 2004, 2005, 2006).

Historically, slower lexical processing in SLI has been viewed as part of a larger domain-general deficit in speed of processing (see Leonard et al., 2007, for a detailed discussion) but there is recent evidence that slower real-time lexical access in children with SLI may result from degraded and/or underspecified lexical representations. In particular, it appears that these poorly specified lexical representations in children with SLI increases their vulnerability to retrieval interference effects and to lexical cohort competition, which results in slower and less efficient lexical processing in these children as compared to TD children (e.g. Coady & Evans, 2008; Crosbie et al., 2004; Evans, 2002; Joanisse & Seidenberg, 1998; Lahey & Edwards, 1996; Mainela-Arnold et al., 2008). Moreover, this inefficiency in lexical processing appears to be related to the slower retrieval and integration of the lexical-semantic properties of incoming words into a developing sentence meaning in children with SLI (Montgomery, 2006).

There are methodological challenges to examining the relationship between lexical processing deficits and sentence processing in children with SLI, however. Research paradigms that use *offline* designs assess sentence comprehension at some point after the sentence is completed. In contrast, *online* comprehension methods that measure words as they are spoken allow for a tighter link between real-time lexical processing and sentence comprehension. Studies that use *online* paradigms like speeded word identification as an index of processing in varying sentence contexts have provided an understanding of the fluency with which children with SLI can understand single words in a variety of sentential conditions (e.g. Montgomery & Evans, 2009; Montgomery, 2004, 2006; Stark & Montgomery, 1995). While these *online* methods provide a more detailed window into sentence comprehension, single-word identification paradigms do not allow for the examination of the continuous changes in lexical activation as it builds over the course of a sentence.