The timecourse of anticipatory sentence comprehension in children with Specific Language Impairment (SLI).

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Abstract
Despite showing numerous deficits in spoken sentence comprehension (Montgomery, 2002) and processing speed (Windor & Haring, 1999), relatively little is known about how children with Specific Language Impairment (SLI) comprehend lexical information as sentences unfold. Arguably, this task requires visual and efficient processing in order to successfully interpret the sentence. A unique and remarkable characteristic of sentence comprehension in typically developing (TD) children is the decreasing speed with which information is integrated across multiple lexical items to anticipate upcoming referents. In this study, we explore the possibility that sentence comprehension and processing deficits in SLI arise from a difficulty in efficiently integrating lexical information across multiple words. Using a similar design to Kamide, Altmann and Haywood (2002), Experiment 2, we examined the timecourse of lexical activation to objects that varied in association to the Agent and Voces of a simple transitive sentence.

Introduction
12 teenagers with a documented history of SLI and typically developing (TD), age-matched controls were tested. Participants’ eye-movements were recorded as they looked at a four-alternative forced-choice display while they heard a sentence in which the object referred to one of the pictures. “The pipe hides the treasure”. The task was to select the picture that best matched the sentence. In addition to the target picture (Target: treasure), nontarget pictures were either related to the agent (Agent-related: ship), related to the actions (Agent-Related: bones), or unrelated (Cat). Pictures were presented at random order, so that all versions of the task were presented.

Results & Conclusions
1. Children with SLI have numerous sentence comprehension difficulties.
   1. They often perform more poorly on sentence tasks that index offline comprehension (Montgomery & Evans, 2009).
   2. In online tasks, they are slower to identify words in sentences (Montgomery, 2006), and slower on numerous measures of linguistic and non-linguistic processing (Kail, 1994).

Eye-movements are able to index rapid cognitive processing in sentence comprehension:
1. Eye-movements have been used extensively to investigate the time-course of word and sentence comprehension in adults and children.
2. This research indicates that adults and children incrementally interpret sentences as sounds unfold over time.
3. Additionally, adults (Kamide et al. 2003; 1999) and children (Borovskey & Elman, in prep; Fernald, in prep; Nation et al. 2003) are capable of using information that occurs earlier in a sentence to anticipate subsequent sentential objects.

Eye-movements measurements in typical children are sensitive to variations in linguistic skill, such as vocabulary level and reading comprehension.
1. Infants with larger vocabularies are faster to fixate on an object when hearing a preceding verb that primes its meaning (e.g. drink the milk; Fernald, in prep.)
2. School-aged children who are less-skilled reading comprehenders show shorter and more numerous anticipatory eye-movements to a target after a related verb.
3. Children and adults with lower vocabulary scores are slower to combine earlier information in sentences to anticipate sentence-final objects (Borovskey & Elman, submitted).

Purpose
To investigate incremental interpretation of simple transitive sentences in adolescents with SLI and age-matched typically developing (TD) peers via eye-gaze measures that reflect real-time linguistic processing.

Figure 1. An example of a visual image in the experiment (FMR), and of two of four auditory sentences paired with this image. The relationship between each sentence and the pictures was balanced such that each object appeared in all conditions across versions.

Online measurement of sentential comprehension:
• Participants completed an experimental task modeled after Kamide, Altmann and Haywood (2003).
• In this task, (Figure 1) participants hear simple, five-word sentences containing an Agent, Action and Object as they view images containing four objects.
• Eye movements were simultaneously recorded.
• The task is to select the image that corresponds to the sentential object.

Participants
• 12 adolescents with a documented history of SLI
• 14 age- IQ-matched typically developing controls (TD)

Demographics:

<table>
<thead>
<tr>
<th>Age</th>
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<th>SLI</th>
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<tbody>
<tr>
<td>14</td>
<td>198.0</td>
<td>204.0</td>
</tr>
<tr>
<td>15</td>
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<td>209.5</td>
</tr>
<tr>
<td>17</td>
<td>266.3</td>
<td>234.0</td>
</tr>
</tbody>
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Figure 2. Proportion of time looking to each interest area averaged over each 10ms bin for participants in both groups. Target diverges from other objects at similar times for both groups: 1940ms for SLI and 1380ms for TD groups.

Results & Conclusions
1. Both SLI and TD groups rapidly activated the agent and action to anticipate the sentence-final object by directing their gaze to the target (Figure 2). The two groups did not significantly differ in the speed with which they anticipated the final object (see red arrows).
2. The TD group temporariliy considered objects that were consistent with the verb, even if not consistent with the agent (see blue arrows, where looks to the Action-related object temporarily increased). This strategy replicates previous findings with younger children and college adults, and may reflect the ability to entertain parallel interpretations of a sentence as it unfolds.
3. The SLI group did not appear to consider such locally-possibly options. This suggests that they may either be unable to maintain multiple competing interpretations or may rely on potentially non-linguistic event-level information to a greater extent than their typically developing peers.
4. There were differences in the overall pattern of gaze fixations, both prior to sentence onset and subsequently while sentences were processed.
5. Children with SLI fixated less on the central regions of each image, and had more diffuse patterns of gaze overall.
6. These differences in patterns of gaze fixation may reflect difficulties by the SLI group in semantic integration of processing during this task.