Teaching Young Children with DLD to Produce Causal Adverbials to Within a Science Curriculum: A Single Case Design Study

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Background / Context:

Both children and scientists spend a great deal of time talking about why things happen. It is not surprising that the Next Generation Science Standards (National Research Council, 2013) identify cause-effect relationships as one of the cross-cutting concepts that apply broadly across domains of science learning. Unfortunately, children with language disorders may struggle with comprehending or producing the language used to talk about causal relationships and other scientific concepts (Donaldson et al., 2007). This project focused specifically on children with developmental language disorder (DLD), children who exhibit language difficulties with no obvious etiology (Bishop et al., 2017). These children not only struggle with language learning and use, but also exhibit poorer academic outcomes, including poorer science outcomes (Matson & Kline, 2012). Early intervention that supports the language of science has the potential to improve long term outcomes.

Children with DLD typically struggle to produce complex sentences, including multi-clause causal sentences (Schuele & Dykes, 2005). Complex causal sentences include a cause, effect, and conjunction that links the two while describing the relationship between them (Diessel & Hetterle, 2011). Thus, a child with DLD may struggle to say a two-clause utterance like “The kite flew because wind pushed it” even if she says the word because regularly. Most of the evidence base regarding language intervention in young children is focused on simple sentences and morphology (e.g. Leonard et al., 2004)

Language intervention focused on cause-effect could help children with DLD to acquire science-relevant language skills at a young age and thereby improve their ability to engage in science learning throughout their school years.

Research Question

1. Can language intervention provided in the context of science instruction lead to gains in production of complex causal sentences for young children with DLD?

2. Can language intervention provided in the context of science instruction lead to gains in science content learning for young children with DLD?

Setting

All research sessions took place one-on-one between the interventionist and participant, with primary sites including meeting rooms at local libraries, a treatment room in the lab on campus, and a quiet room at a child’s home.

Participants

Participants were 7 children with DLD. All participants attended school districts that used the Full Option Science System (FOSS) as their science curriculum, though preschool participants had not yet been exposed to any FOSS lessons.
One participant withdrew from the study following several sessions of intervention. The remaining 6 children completed the study in full. See Table 1 for more detail regarding participants.

**Intervention**

The intervention consisted of language intervention within science instruction. That is, children completed science lessons during which the interventionist, a licensed Speech-Language Pathologist, targeted production of complex causal sentences with *because* and *so*.

All science instruction consisted of lessons modified from the FOSS – 3rd Edition First Grade curriculum (FOSS, 2013). The structure of the lessons included components typical of science instruction in this age range (French, 2004):

1. Book sharing
2. Experiment or observation
3. Completing a science notebook entry
4. Verbally explaining findings

The language intervention consisted of standard techniques for teaching grammar to children in this age group, including adult models of target sentence types and recasts of child utterances into complex causal sentences. A recast occurs when a child produces an utterance (e.g. The kite go up! Wind push it!) and the adult replies with an utterance that has the same general message, but uses the target grammatical form (e.g. The kite went up because wind pushed it!). This is an effective approach for teaching morphology to young children with DLD (Cleave et al., 2015) but has not been previously tested with complex sentence types.

**Research Design**

This study used a multiple probe design. Participants moved across three phases: Baseline (probes only), Science Only (science teaching, but no language intervention) and Science Plus (science teaching with language intervention).

Complex causal sentence probes and untaught control sentence probes were administered during each session. The untaught control sentence type provides an additional protection for validity. If children improve only on the sentence type addressed in the intervention, it suggests the intervention is more likely causing the change than if children improve on both the control and taught sentence types.

Children completed science content probes at each session, and completed science unit tests prior to intervention and following completion of each unit.

**Data Collection and Analysis**

Trained raters who were blinded to the goals of the language intervention scored all language and science content probes through use of video and audio recordings. Fidelity was assessed via review of videotaped sessions by trained raters.
The primary method of analysis consisted of visual analysis of daily probes. This was supplemented with use of Tau-U effect size calculations both within and across phases (Parker et al., 2011).

Findings

See Figures 1 and 2 for daily probes of language and science content and Figure 3 for science unit test performance.

Six of seven participants exhibited gains in because sentences following introduction of language intervention. No participants exhibited gains prior to intervention, and no participant exhibited gains on the untaught control sentence types. Degree of gain varied across participants, and may relate to individual differences in language learning profiles. There was no clear effect on so sentences.

Performance on science unit tests at pre-test and post-test indicate that children learned science content during the intervention, but the pattern did not reflect additional gains related to language learning.

Conclusions

Children with DLD can learn to use complex causal sentences when provided with language intervention during science instruction. This means that language goals at this age can include academically relevant targets that occur frequently during science instruction.

Young children with language disorder can learn new science content delivered in concert with language intervention. It is not clear if teaching children to use the sentence types common in science settings directly benefits future science learning. This approach to intervention provides insight into the potential for practitioners to teach new language skills in authentic contexts that address the demands of general education curricula.
Table 1: Participants

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Age</th>
<th>Grade</th>
<th>Sex</th>
<th>Receives SLP&lt;sup&gt;a&lt;/sup&gt; services?</th>
<th>SPELT-3&lt;sup&gt;b&lt;/sup&gt; Standard Score</th>
<th>K-BIT2&lt;sup&gt;c&lt;/sup&gt; Standard Score</th>
<th>Control Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1: Adam</td>
<td>4;0</td>
<td>Pre-K</td>
<td>M</td>
<td>Yes</td>
<td>93</td>
<td>95</td>
<td>Passives</td>
</tr>
<tr>
<td>Tier 2: Breanna</td>
<td>5;6</td>
<td>K</td>
<td>F</td>
<td>No</td>
<td>94</td>
<td>112</td>
<td>Passives</td>
</tr>
<tr>
<td>Tier 3: Connor</td>
<td>5;11</td>
<td>K</td>
<td>M</td>
<td>Yes</td>
<td>92</td>
<td>92</td>
<td>Relative Clauses</td>
</tr>
<tr>
<td>Tier 1: David</td>
<td>4;10</td>
<td>Pre-K</td>
<td>M</td>
<td>No</td>
<td>70</td>
<td>88</td>
<td>Passives</td>
</tr>
<tr>
<td>Tier 2: Edward</td>
<td>5;1</td>
<td>Pre-K</td>
<td>M</td>
<td>Yes</td>
<td>66</td>
<td>97</td>
<td>Passives</td>
</tr>
<tr>
<td>Tier 2: Eli</td>
<td>4;4</td>
<td>Pre-K</td>
<td>M</td>
<td>Yes</td>
<td>77</td>
<td>101</td>
<td>Relative Clauses</td>
</tr>
<tr>
<td>Tier 3: Francesca</td>
<td>6;3</td>
<td>K</td>
<td>F</td>
<td>Yes</td>
<td>59</td>
<td>86</td>
<td>Passives</td>
</tr>
</tbody>
</table>

<sup>a</sup> Speech-Language Pathology services; <sup>b</sup> Structured Photographic Expressive Language Test: Third Edition; <sup>c</sup> Kaufman Brief Test of Intelligence – 2<sup>nd</sup> Edition, Matrices Subtest
Breanna withdrew following 8 sessions of Science Plus; unconnected data points indicate intermittent data collection, solid lines indicate continuous data collection.
Figure 1: Daily Probes For Cohort One

Unconnected data points indicate intermittent data collection, solid lines indicate continuous data collection.