



The impact of lexical competition and response inhibition control on performance on a sentence span task in children with SLI

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Abstract

Many investigations have suggested that the underlying impairment in specific language impairment (SLI) is limited working memory capacity. Recent studies have reported that children with SLI exhibit poor suppression or greater activation of competitors in tasks that are apparently low in working memory demands. In the current study, we investigated the hypothesis children's performance in working memory tasks can be explained by vulnerability to lexical competition and/or poor response inhibition control. 16 children with SLI and 16 CA peers (ages 8;5-12;3) participated. Three measures were collected: (1) Sentence Span, words recalled in a working memory task, (2) Competition, non-target competitor words produced in gating tasks, and (3) Response Control, ability to delay word repetition response until a response signal. For the SLI group, a significant association between Sentence Span and the ability to inhibit potential responses (Response Control) was found. This suggests that working memory deficits can in part be explained by lexical skill states that are not strong enough to inhibit irrelevant or incorrect processes.

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Rationale

Many current investigations have suggested that the underlying impairment in specific language impairment (SLI) might be limited verbal working memory capacity (e.g. Ellis Weismer et al., 1999; Leonard et al., 2007). Recently, children with SLI have been reported to exhibit poor suppression or greater activation of competitors in tasks that are apparently low in working memory demands (e.g. Mainela-Arnold et al., 2005; McMurray et al., 2006). Current developments in connectionist modeling and neuroscience suggest that what has been referred to as working memory capacity may comprise of global competition of activation in large scale neural networks with a top-down bias from prefrontal cortex (PFC) circuits (for review Maia & Cleeremans, 2005). On one hand, evidence suggests that newly emerging skills are more vulnerable to interference effects from competing processes, than older, well learned processes (e.g. Cohen et al., 1990). On the other hand, PFC circuits appear to maintain contextual representations that bias the competition between processes and modify the focus of attention quickly and flexibly (e.g. Frank et al., 2001). In an earlier study, we found that children with SLI activate more competitors in a lexical access task when compared to peers (Mainela-Arnold et al. 2005). This suggests that the lexical skill states in children with SLI may not be strong enough to inhibit irrelevant competitors, i.e. that lexical representations of children with SLI may resemble those of newly learned words in the lexicons of typically developing children. It is also possible that children with SLI experience weaker top-down PFC control.

Current study

We investigated if children's performance in verbal working memory tasks can be explained (1) susceptibility to lexical competition, and/or (2) lower top-down response inhibition control.

Participants

16 children with SLI and 16 age and nonverbal IQ matched controls (CA), ages 8;5-12;3.

Tasks and Variables

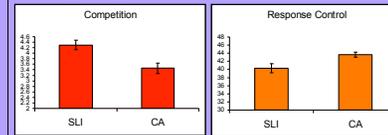
All children completed three different experimental tasks for which the target word stimuli were the same 48 words. The following three measures were collected corresponding to the three tasks:

- Sentence Span**, the number of words recalled in a sentence span task. Children listened to lists of true and false sentences. After a list of sentences, children recalled the target last words of each sentence. The lists included an increasing number of sentence per list, thus this task included an increasing working memory component.
- Competition**, the mean number of non-target competitor words produced in a gating task. Children heard segments of words, differing in duration (10 gates, 120ms – 660ms duration) and guessed after each gate, what the word might be. *Competition* measure gave us an insight to susceptibility lexical competition in a situation that is low in working memory demands.
- Response Control**, the number of times the child correctly waited before responding when presented with a delayed repetition task. Children were asked to repeat a word after waiting for a response signal that was either presented with a short delay (300 ms) or long delay (1000 ms). Correct repetitions in the long delay condition were calculated. *Response Control* gave us a measure of top-down control corresponding to task instructions in a situation that is otherwise low in working memory demands.

Examples of the Sentence Span, Gating and Delayed Repetition tasks and the corresponding variables Sentence Span, Competition, and Response Control

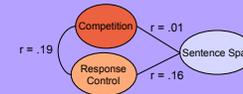
(1) Sentence Span Task - Sentence Span									
Stimulus	People can work Bugs are big Snow is hot								
Example of words recalled	'hot big'								
(2) Gating Task - Competition									
Stimulus: Acoustic chunks of the word 'big'									
1	2	3	4	5	6	7	8	9	10
120ms	180ms	240ms	300ms	360ms	420ms	480ms	540ms	600ms	660ms
Response	'bear'	'big'	'better'	'beg'	'bend'	'big'	'big'	'big'	'big'
Example									
Non-target competitors: bear, better, beg, bend (4)									
(3) Delayed Naming Task - Response Control									
Stimulus	Big.....Response signal 'beep' after 1000 ms delay								
Correct response control	Big.....beep.....Big								
Failure in response control	Big.....'big'.....beep.....'oh big'								

Do children with SLI differ from their peers in their ability (1) to inhibit lexical competitors and (2) to control their responses according to simple task directions?



Children with SLI produced significantly more competitor words in the gating task, $t(30) = 3.240, p < .05$ and had significant difficulty inhibiting their responses until the response signal when compared to the CA peers, $t(23.26) = 2.60, p < .05$, unequal variances assumed.

CA group Is inhibition of lexical competitors and response control associated with performance in working memory tasks in children with typical development?



None of the simple or partial correlations between Competition, Response Control and Sentence Span reached significance in the CA group.

Summary

Children with SLI exhibited significant difficulty inhibiting lexical competitors and top-down response control. Response Control was significantly associated with working memory performance and mediated the association between lexical competition and working memory performance in children with SLI. These associations were not found in typically developing children.

Discussion

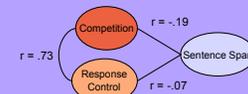
The results indicate that word recall performance in verbal working memory task in children with SLI is significantly influenced by the ability to inhibit potential responses. The working memory deficit children with SLI exhibit, can be at least in part, explained by (1) lower top-down response inhibition control, (2) lexical skill states that are not strong enough to inhibit or override irrelevant competing processes, and (3) the interaction between the two. Future research should investigate how these inhibition processes change as a function of increasing skill levels in both in typically developing children and children with SLI.

SLI group Is inhibition of lexical competitors and response control associated with performance in working memory tasks in children with SLI?

Partial correlations for the SLI group revealed a significant correlation between Sentence Span and Response Control with Competition controlled for, $r = .56, p < .05$.

Simple correlation between Sentence Span and Competition for the SLI group was $r = -.19, p = .46$. Partialing out Response Control increased the correlation to $r = -.412, p = .13$, suggesting that Response Control mediated the association between Competition and Sentence Span.

For the children with SLI who had lower Response Control, there appeared to be an association between Competition and Response Control, but Competition and Response Control were not associated with Sentence Span.



For the children with SLI who had higher Response Control, both Competition and Response Control were associated with Sentence Span.

