



# Phonological memory and word learning deficits in children with specific language impairment: A role for perceptual context?



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## ABSTRACT

**Background:** Sensitivity to perceptual context (anchoring) has been suggested to contribute to the development of both oral- and written-language skills, but studies of this idea in children have been rare.

**Aims:** To determine whether deficient anchoring contributes to the phonological memory and word learning deficits of children with specific language impairment (SLI).

**Methods and procedures:** 84 preschool children with and without SLI participated in the study. Anchoring to repeated items was evaluated in two tasks – a phonological memory task and a pseudo-word learning task.

**Outcomes and results:** Compared to children with typical development, children with SLI had poorer phonological memory spans and learned fewer words during the word learning task. In both tasks the poorer performance of children with SLI reflected a smaller effect of anchoring that was manifested in a smaller effect of item repetition on performance. Furthermore, across the entire sample anchoring was significantly correlated with performance in vocabulary and grammar tasks.

**Conclusions and implications:** These findings are consistent with the hypothesis that anchoring contributes to language skills and that children with SLI have impaired anchoring, although further studies are required to determine the role of anchoring in language development.

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## What this paper adds?

Currently accepted accounts of SLI emphasize the heterogeneity of this diagnosis, but the interactions of language-specific and domain-general processes in the manifestation of SLI are not well understood. In this paper, it is reported for the first time, that the phonological memory and word learning deficits characteristic of children with SLI are exacerbated under conditions that allow typically developing children to benefit from the perceptual context induced by stimulus repetitions. It is also reported that across the range of language abilities tested, the magnitude of the perceptual context effect is correlated

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with performance in vocabulary and grammar tasks. The data reported in this paper thus extends previous findings of perceptual context deficits in dyslexia to SLI and raises the possibility that sensitivity to perceptual context contributes to the development of both oral and written language. The present findings are discussed in the context of the procedural deficit hypothesis and the generalized slowing accounts of SLI as well as in the context of findings from statistical learning. Based on this discussion it is proposed that reduced sensitivity to perceptual context in SLI may represent a broader impairment in distributional statistical learning in SLI and that further studies are required to determine whether this proposal is true.

## 1. Introduction

By the time they reach the preschool education system, an estimated 7% of children have failed to develop age-appropriate language skills, even though their development in other domains and their non-verbal cognitive abilities are within the normal range, a condition usually termed specific language impairment (SLI) (Bishop, 2014; Leonard, 2003; Tomblin et al., 1997). Despite numerous theoretical accounts, the variables contributing to SLI remain debated (Bishop, 2006b; Montgomery, Magimairaj, & Finney, 2010; Ullman & Pierpont, 2005). Motivated by multi-deficit accounts of developmental disorders (Bishop & Rutter, 2008; Pennington, 2006; Pennington & Bishop, 2009) and by evidence for significant relationships between early oral language skills and later reading skills (Boets, Wouters, van Wieringen, De Smedt, & Ghesquiere, 2008; Flax, Realpe-Bonilla, Roesler, Choudhury, & Benasich, 2009; Gooch, Hulme, Nash, & Snowling, 2014; Muter, Hulme, Snowling, & Stevenson, 2004; NELP, 2008; Puolakanaho et al., 2008), the goal of the present study was to test aspects of the anchoring deficit hypothesis (Ahissar, 2007) in children with SLI. Anchoring is defined as sensitivity to recent perceptual context, a context induced by the repetition of information across trials in the time range of seconds to minutes (Ahissar, 2007; Ahissar, Lubin, Putter-Katz, & Banai, 2006). Anchoring effects occur in various domains ranging from auditory discrimination and speech recognition to phonological memory, pseudoword reading (Ahissar et al., 2006; Oganian & Ahissar, 2012) and rapid naming (Di Filippo, Zoccolotti, & Ziegler, 2008). Together these studies suggest that anchoring could play a role in perceptual as well as in language processes. Most relevant in the context of the present study, anchoring deficits in persons with dyslexia were observed across the range of tasks used to elicit anchoring – auditory discrimination, phonological memory and pseudoword reading tasks (Ahissar et al., 2006; Inoue, Higashibara, Okazaki, & Maekawa, 2011; Oganian & Ahissar, 2012). Here we aimed to determine whether anchoring is similarly impaired among children with SLI. To this end, we selected two areas in which the difficulties of children with SLI are well documented – phonological memory (for review see Montgomery et al., 2010) and word learning (for review see Kan & Windsor, 2010) and asked whether anchoring could account for part of their deficit.

### 1.1. Anchoring to recently presented information

Perception of stimuli of various levels of complexity was found to be better (more accurate, faster or both) when assessed in the context of a small set of frequently repeating items than when perception of the same stimuli is measured with little or no stimulus repetition (Banai & Yifat, 2011; Bull & Cuddy, 1972; Harris, 1948; Nahum, Daikhin, Lubin, Cohen, & Ahissar, 2010; Wong, Peng, Fratus, Woodman, & Gauthier, 2014), a phenomenon called anchoring (Harris, 1948; Ahissar, 2007). In a seminal study on the discrimination of pure tones, Donald Harris (1948) tested frequency discrimination in two conditions. In both conditions listeners were presented with two tones on each trial and had to determine which tone was higher in pitch. In one condition one of the tones served as a reference that was consistently presented on all trials, whereas no such reference existed in the other condition. Discrimination thresholds were better in the condition with the consistent reference tone than in the other condition. Harris suggested that the repetition of the reference created for the listener ‘a psychological reference point’ or ‘an anchor’ which consequently improved their performance. Theoretically, anchoring effects were modeled within a Bayesian framework (Raviv, Ahissar, & Loewenstein, 2012). In this framework, perception results from combining current sensory input with prior knowledge and expectations that are based on previously encountered stimuli. When a single reference tone is repeated across trials, the similarity of the reference tone to an implicit memory trace that is created based on previously encountered stimuli is greater than in cases in which no repetition occurred. This in turn will facilitate performance on the current trial (Raviv et al., 2012).

There is no reason to believe that the effects of across-trial repetitions should be limited to frequency discrimination. Indeed, over the years, similar findings were reported not only for simple stimuli, but also for more complex ones such as visual objects (Di Filippo et al., 2008; Wong et al., 2014), syllables (Banai & Yifat, 2012; Oganian & Ahissar, 2012) and pseudowords (Ahissar et al., 2006; Oganian & Ahissar, 2012). For example, it has been recently shown that the superior ability of experienced musicians to visually recognize (musical) note-like stimuli depended on the consistent presentation of the notes on a horizontal staff. Changing the orientation of the staff over trials was detrimental to performance (Wong et al., 2014). Likewise, when required to compare the pitch of tones over different retention intervals, memory decay was slower when the same small set of tones was repeated over trials than when a larger set of tones was used (Bull & Cuddy, 1972). The ability to determine, on a given attempt, that two stimuli were identical (or different) would not have depended on the stimuli presented on previous attempts if participants were engaged in a direct comparison of the stimuli before making

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