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Perception and short-term memory for verbal information in children with specific language impairment: Further evidence for impaired short-term memory capacities

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Most children with specific language impairment (SLI) present impaired performance in verbal short-term memory (STM) tasks. Weismer et al. (2000), for example, showed that repetition of non-words of increasing length, a frequently used STM measure, was a very reliable marker for distinguishing children with and without SLI. This has led a number of authors to consider that a verbal STM impairment might represent one of the core deficits of SLI (e.g., Gathercole & Baddeley, 1990). However, there is still important controversy regarding this view as the verbal STM impairment could also be the consequence of underlying language impairments. For example, James, Van Steenbrugge, and Chiveralls (1994) observed deficits in speech perception that explained impaired performance observed in verbal STM tasks in their SLI group. Furthermore, another possibility which has not yet been extensively explored is that the poor development of SLI children's phonological and lexico-semantic representations stored in long-term memory (LTM) could also account for reduced performance in STM tasks. Indeed, a number of studies in normally developing children have recently shown that performance in STM tasks is very strongly influenced by the integrity of underlying LTM language representations, as evidenced by better recall for words compared to nonwords and better recall for non-words containing familiar versus less familiar phoneme associations (e.g., Gathercole, Frankish, Pickering, & Peaker, 1999). In this context, we re-examined the specificity of verbal STM deficits in SLI by exploring the influence of phonological and lexico-semantic LTM representations on STM performance as well as the integrity of speech perception abilities.

Twelve French-speaking children (7;5—12;3 yr) diagnosed with SLI by a certified speech language pathologist, 16 normally developing children (8;0-11;6 yr) matched for chronological age and nonverbal intelligence (CA controls) and 16 younger controls (6;10-11;6 yr) matched on receptive and productive vocabulary measures (VA controls) participated in this study. All SLI children had a nonverbal IQ > 80 and were impaired relative to both control groups in sentence production, grammatical comprehension and phonological awareness tasks. The SLI children were also impaired on receptive and productive vocabulary measures relative to CA controls.

A first set of experimental tasks assessed speech perception abilities. CVC word and nonword pairs were presented auditorily. The items of each pair were either identical, either differed by one or two phonemes. The children judged whether the two items were identical or not, by pressing on left or right buttons of a response box. Both reaction times and response accuracy were measured. A second set of tasks assessed STM abilities. Sequences of CVC words and nonwords were auditorily presented for immediate serial recall, at two different lengths (four items and five items). Number of items correctly recalled was determined. Articulation rate for words and nonwords was also obtained by measuring the time needed to repeat word or nonword pairs five times as quickly as possible. Most importantly, in both STM and speech perception tasks, advantage in performance for words versus non-words was determined, allowing us to measure the influence of long-term lexico-semantic representations supposed to facilitate processing and temporary storage of words (lexicality effect). Furthermore, the nonwords also contained phoneme associations that were either frequent (HF nonwords) or infrequent (LF nonwords) in French phonology; comparison between the two types of nonwords permitted us to assess the influence of sublexical phonological LTM representations supposed to facilitate processing and temporary storage of HF non-words (phonotactic frequency effect).

The different measures were analyzed by mixed ANOVAs, with group and stimulus condition (word, HF nonword, and LF nonword) as between- and within-subject factors, respectively. Regarding response accuracy on the speech perception task, no group effect was obtained ($F(2, 41) < 1$); a main effect of stimulus condition was obtained ($F(2, 82) = 6.34$, $P < .005$) that furthermore interacted with group ($F(4, 82) = 3.01$, $P < .05$). Planned comparisons showed that the lexicality (words versus HF nonwords) and phonotactic frequency (HF versus LF nonwords) effects were only significant in the VA controls, but not in the SLI and the CA groups.

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Regarding reaction times, no group effect ($F(2, 41) = 2.13$, $P > 0.1$) but a significant effect of stimulus condition ($F(2, 82) = 6.34$, $P < .005$) was observed. Planned comparisons showed that the phonotactic frequency effect was significant only in the two control groups, but not in the SLI group; the lexicality effect did not reach significance in any group. For STM measures, a main effect of group ($F(2, 41) = 9.76$, $P < .001$) and of stimulus condition was observed ($F(2, 82)=257,71$, $P < .001$). Planned comparisons showed that level of performance in the SLI group was significantly lower than in both control groups for each stimulus condition. The phonotactic frequency and the lexicality effects were significant in each group. Finally, no significant group difference was obtained regarding articulatory rate measures ($F(2, 41) < 1$).

Our results show that accuracy and speed of speech perception are not impaired in SLI and thus cannot account for the impaired performance in verbal STM tasks, even if SLI children might use a nonpho-nological (acoustical) strategy as suggested by the absent phonotactic frequency effect for reaction time measures, relative to both control groups. Furthermore, in the STM task, normal lexicality and phonotactic frequency effects were observed showing that the influence of phonological and lexico-semantic representations on STM performance was preserved in SLI. Most importantly, STM performance was reduced even for LF nonwords where a contribution of LTM language representations is very minimal. These data clearly support the existence of important limitations in verbal STM capacity in SLI.

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