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Concurrent Performance of Two Memory Tasks: A Comparison between Normal Children and Children with Stuttering

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Abstract

Introduction

Working memory, a functional space in which data is manipulated as well as stored. It is a multidimensional system comprising several interactive, interrelated mechanisms. These include phonological short-term memory (PSTM) storage buffer, a visuo-spatial short-term memory buffer and attentional resource control function (Bayliss et al. 2005, Conlin et al. 2005). Sources of information that are needed in comprehending a sentence are stored in working memory. The types of information stored include meaning of the word, its role in grammar, and the structures in which it can appear, and the role it plays in sentence meaning.

A concurrent verbal processing-storage (CPS) task was used as the index of attentional resource control/allocation by Marton and Schwartz (2003) & studied by Kane et al. (2001, 1999). This task was regarded to reflect children's domain-general use of controlled and flexible attentional abilities, i.e., allocation of attention to the language processing system and phonological short term buffer (or PSTM). This task invites children to divide their attentional resources between language processing (i.e., comprehend the sentence) and verbal storage (i.e., retain final words/repeat non-words).

The concurrent processing storage task can be used to score the performance of the children when the complexity of the sentence and the syllable length of non-words were varied. The task entails just the sort of resource allocation assumed to take place during sentence processing (i.e., attention to verbal processing and storage simultaneously), especially for complex sentences. Hence it checks concurrent performance of two memory tasks.

The literature is rich with studies exploring the influence of working memory on listeners' (or readers') sentence processing (e.g., Caplan and Waters 1999, Chen et al. 2005). There is considerable evidence showing that increases in syntactic complexity place a burden on listeners' working memory system, despite the listener possessing automatic/obligatory language processing schemes. That is, increases in syntactic complexity typically lead to reduce comprehension accuracy (Chen et al. 2005, Just and Carpenter 1992).

Need for the Study

There is a longstanding literature that has examined whether the language abilities of children who stutter (CWS) are equivalent to those of children who do not stutter (CWNS Bernstein Ratner, 1997). Examining language competencies of CWS has accounted that "stutterers are late in passing their speech milestones perform more poorly than nonstutterers on some tests of language" (Andrews et al., 1983, Ratner, 1995). The claim that global language deficits exist among persons who stutter remains tentative because several studies in this area have yielded mixed results.

Some researchers have found CWS to have depressed scores on syntactic measures obtained through spontaneous speech samples, and lower scores on measures of articulation, language, and speaking rate (Ryan, 1992). Speech-sound disorders among CWS have been noted in many reports although incidence figures of speech-sound disorders among CWS vary widely (Blood & Seider, 1981; Bloodstein, 1987 Wolk, Edwards, & Conture, 1993) hence CWS may have deficit in phonological processing leading to a difficulty in decoding and recognition of words. Hence it is interesting to compare the performance of children with stuttering with that of the normal children on concurrent verbal processing-storage (CPS) task. This may give information about semantic and phonological working memory skills of children with stuttering, which contributes to the need for the present study.

Aim of the study

To compare the Attentional Resource Control abilities of CWS with normal children.

Method

Participants The participants in the study included twenty children with mild stuttering and twenty normal children in the age range of 10-15 years. All the subjects were monolingual native speakers of Kannada. All the participants could read Kannada. All the subjects with stuttering were diagnosed as having Stuttering by a qualified Speech Language Pathologist and severity was judged using stuttering severity instrument (SSI).

Test Stimuli The stimuli were adopted from unpublished dissertation "Role of working memory in typically developing children's complex sentence comprehension" (Shwetha M. P., 2009). This task had 20sets of simple and complex sentences with non-words at the end of each sentences. The task-included sentences that were well within the linguistic competence of all the children any difference could be attributable to age-related differences in resource allocation, not linguistic knowledge.

Procedure Each test sentence was played using headphones that was stored in a computer. Child was instructed respond to question asked and also to repeat non-word, which was heard at the end of the sentence. Two response conditions were used, in first set the child has to repeat non-word first (immediate repetition) & have to answer to the questions, which was heard. In second set child has to respond for the question and then repeat the nonword (delayed repetition). This criterion was used so as to load the PSTM and semantic memory alternately. This was done for simple and complex sentences, which finally contributed to four test conditions. The number of correct answers and correct repetitions were scored.

Results and Discussion The results of independent sample "t" test showed that for all the four test conditions normal children outperformed CWS with highly significant differences between the groups (p=0.00). The mean scores of children with CWS were 5.6, 6.3 for immediate repetition and 4.6, 4.0 delayed repetition of non-word, whereas normal children scored 9.0, 8.9, 9.3, and 8.8. Non-word repetition scores did not differ for immediate or delayed repetition in normal children. The semantic judgment scores of children with CWS were 7.4,6.8 (when judged after non-word repetition), 7.1 and 6.8(when judged immediately listening to the sentences) whereas normal children scored 8.5,8.8,8.5 and 8.6 for semantic judgment tasks. The results suggested that there was no effect of alternate semantic and phonological loading on normal children whereas CWS performed poorly when they have to retain information for longer time in working memory to respond for the task, which was also indicated by results of paired sample t test; that is discrepancy was highly significant when phonological working memory was loaded and complex sentences ($p=0.00<0.05$) [simple sentences ($p=0.00<0.05$)] and differences were not statistically significant for semantic loading. No such differences were found in normal children. The results for this group are in consonance with previous studies implicating speech perception impairments & language-processing deficits in this population (Louko, 1995; Nippold, 1990, 2002; Ratner, 1995, 1997).

Conclusion: The findings of the present study showed that children with CWS more errors on non-word repetition and semantic judgment tasks compared to normal children. The affected children also showed differences in performances when the working memory was loaded; from which it can be inferred that phonological and semantic processing errors can be attributed to poor working memory skills. These findings on stuttering-language dynamics, helps to examine how phonological variables interact with dysfluencies also may be valuable in meeting the challenges of treatment for CWS, particularly those with concomitant disorders.

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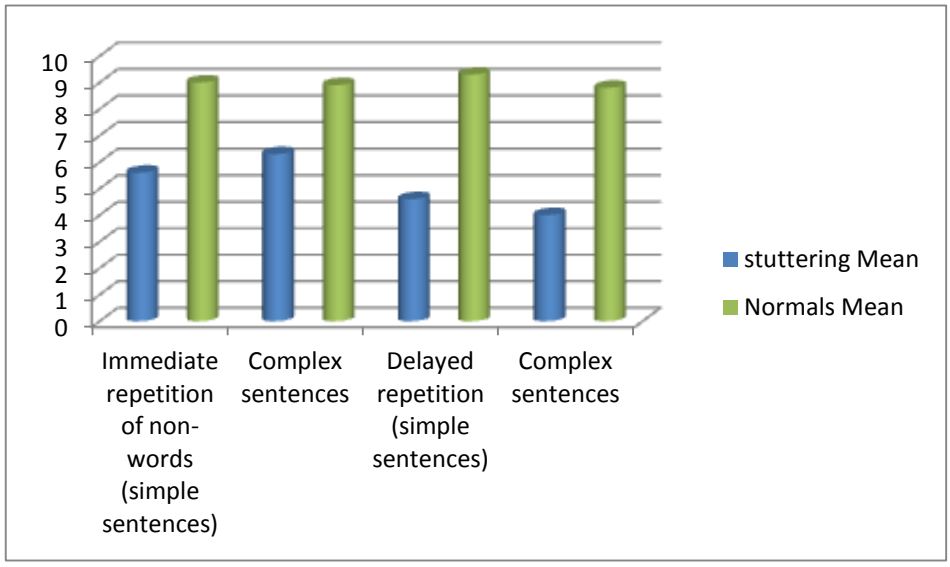
sentences, which finally contributed to four test conditions. The number of correct answers and correct repetitions were scored.

Results and Discussion

The scores obtained for different tasks by two groups of children were tabulated and statistically analyzed using SPSS version 10 software. The results are as follows

Table 1: shows mean scores and standard deviation of CWS and normal children for immediate and delayed repetition of simple and complex sentences.

	CWS		Normal Children		P value
	Mean	S.D	Mean	S.D	
Immediate repetition of non-words (simple sentences)	5.6	1.12	9.0	0.53	0.006
Complex sentences	6.3	1.76	8.9	0.74	0.009
Delayed repetition (simple sentences)	4.6	2.11	9.3	0.44	0.000
Complex sentences	4.0	1.7	8.8	0.58	0.000

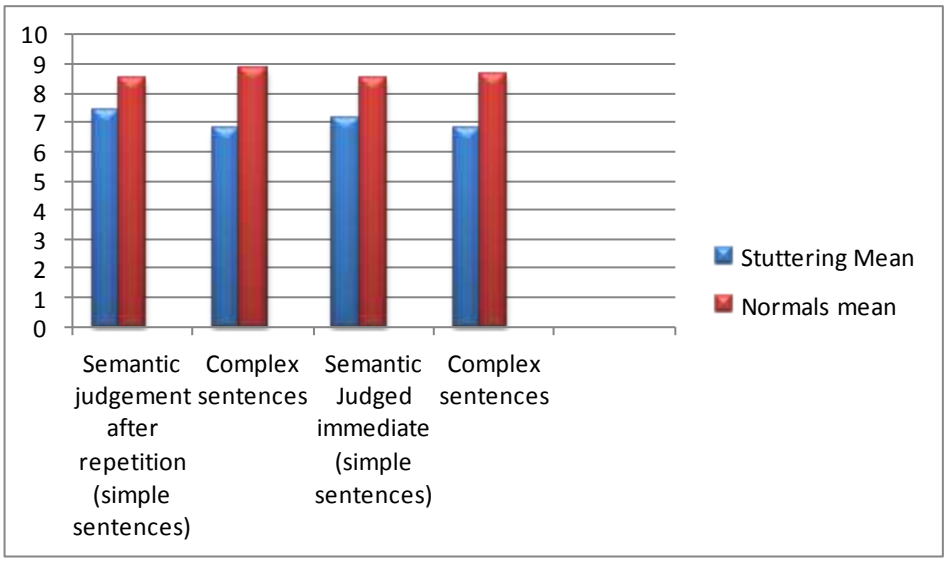


Graph 1:

Table 1 shows the mean scores CWS and normal children for immediate repetition and delayed repetition of non-words. The means scores were 5.6, 6.3 for immediate repetition and 4.6, 4.0 for delayed repetition of non- words respectively. Whereas normal children's mean score were 9.0, 8.9, 9.3, and 8.8 respectively, and the same have been depicted in the Graph 1.

Table 2: shows mean scores and standard deviation of CWS and normal children for semantic judgment.

	Stuttering		Normal		p value
	Mean	S.D	Mean	S.D	
Semantic judgment after repetition (simple sentences)	7.4	2.23	8.5	0.74	0.000
Complex sentences	6.8	2.58	8.8	0.69	0.004
Semantic Judged immediate (simple sentences)	7.1	2.55	8.5	1.24	0.032
Complex sentences	6.8	2.17	8.6	1.05	0.004

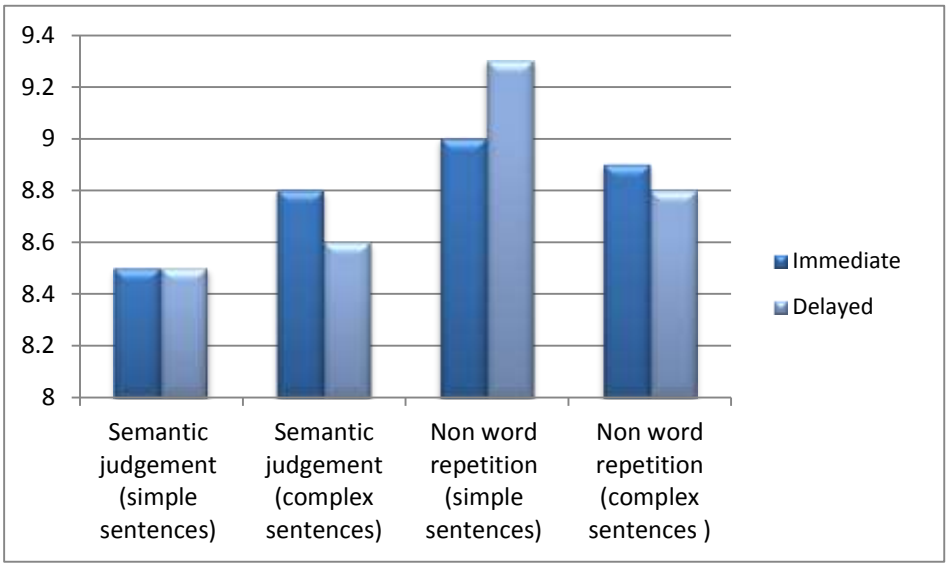


Graph 2:

Table 2 shows the mean scores CWS and normal children for semantic judgment task. The means scores for CWS were 7.4, 6.8 (when judged after nonword repetition), 7.1 and 6.8(when judged immediately listening to the sentences) respectively. Whereas normal children's mean score were 8.5, 8.8, 8.5 and 8.6 respectively, and the same have been depicted in the Graph 2.

Table 3: shows mean scores and standard deviation of semantic judgment and non-word repetition for CWS and normal children.

	Immediate judgment		Delayed judgment		P value
	Mean	SD	Mean	SD	
Semantic judgment (simple sentences)	8.5	0.74	8.5	1.24	1.0
Semantic judgment (complex sentences)	8.8	0.69	8.6	1.05	0.372
Non word repetition (simple sentences)	9.0	0.53	9.3	0.44	0.178
Non word repetition (complex sentences)	8.9	0.74	8.8	0.58	0.629

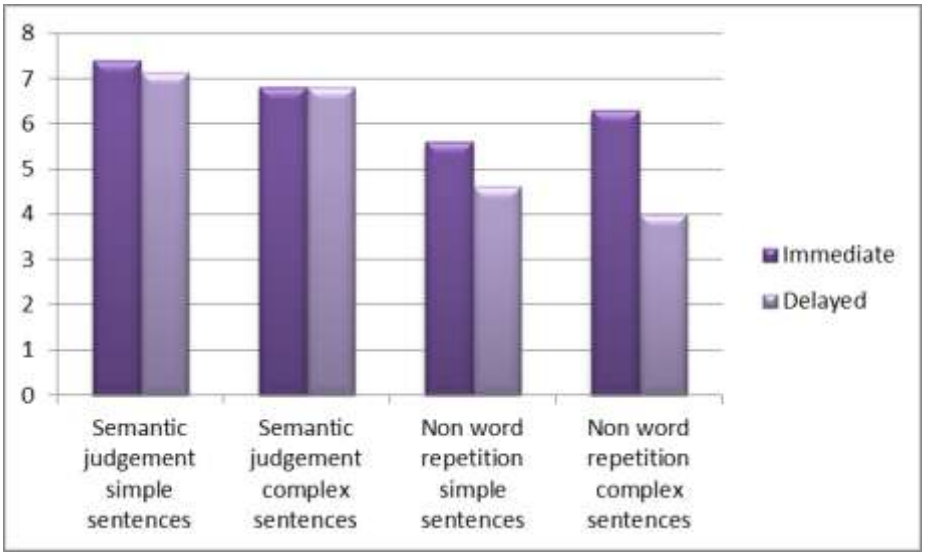


Graph 3:

Table 3 shows the mean scores of normal for semantic judgment task and non-word repetition. The means scores for semantic judgment of simple and complex sentences for immediate judgment were 8.5, 8.8 and for delayed judgment were 8.5 and 8.6 respectively. Whereas for non-word repetition of simple and complex sentences the mean score was 9.0, 8.9 for immediate and 9.3, 8.8 for delayed repetition respectively, and the same has been depicted in the graph 3.

Table 4: shows mean scores, standard deviation and P value of semantic judgment and non-word repetition for immediate and delayed judgment

	Immediate judgment		Delayed judgment		
	Mean	SD	Mean	SD	P value
Semantic judgment (simple sentences)	7.4	2.23	7.13	2.55	0.503
Semantic judgment (complex sentences)	6.8	2.58	6.8	2.17	0.903
Non word repetition (simple sentences)	5.6	1.12	4.6	2.11	0.046
Non word repetition(complex sentences)	6.3	1.76	4.0	1.7	0.002



Graph 4:

Table 4 shows the mean scores of CWS for semantic judgment task and non-word repetition. The means scores for semantic judgment of simple and complex sentences for immediate judgment were 7.4, 6.8 and for delayed judgment were 7.1 and 6.8 respectively. Whereas for non-word repetition of simple and complex sentences the mean score was 5.6, 6.3 for immediate and 4.6, 4.0 for delayed repetition respectively, and the same has been depicted in the graph 4.

The results suggested that there was no effect of alternate semantic and phonological loading on normal children whereas CWS performed poorly when they have to retain information for longer time in working memory to respond for the task, which was also indicated by results of paired sample t test; that is discrepancy was highly significant when phonological working memory was loaded and complex sentences ($p=0.00<0.05$) [simple sentences ($p=0.00<0.05$)] and differences were not statistically significant for semantic loading. No such differences were found in normal children. The results for this group are in consonance with previous studies implicating speech perception impairments & language-processing deficits in this population (Louko, 1995; Nippold, 1990, 2002; Ratner, 1995, 1997).

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