Improving Verbal Working Memory though Visuospatial Stimulation with Future Theoretical Implication in Down's Syndrome

Ritika Singh[1], Bhowmick Kandpal[2]

[1]Senior Audiologist and Speech Language Pathologist, Srajan Spastic Society, Haldwani, India

[2]Assistant Professor, Department of Audiology, Institute of Health Sciences, Bhubaneswar, India

Abstract: ***Working memory is made up of three components, the central executive, the phonological loop, the visuo - spatial scratch - pad. Working memory can be strengthened by working on any of these individually or in coherence. This longitudinal study was conducted to access the impact of visuospatial stimulation through the use of jigsaw puzzle on verbal working memory as reflected by digit span.32 adults with minimum ability to recognise numbers, cleaved in two groups, 20 - 25 years as young adults in group I and above 60 years older adults in group II. Digit forward span and backward span was examined pre and post visuo - spatial stimulation in each group, and the results revealed that practice of visuo - spatial stimulation has improvement in verbal working memory. There was significant difference between pre - evaluation and post evaluation after some amount of visuo - spatial stimulation practice in digit forward and backward verbal working memory span in both groups. As people with Downs syndrome have a specific impairment in short - term memory for verbal information the study propose that this domain can be improved by working on the visuo - spatial domain which is already a stronger suit for people with Downs syndrome.***

Keywords: Working memory, Verbal working memory, Visuo - spatial working memory, Digit forward span, Digit backward span

1. Introduction

Memory is a sequential process of encoding, storing and retrieving information. Encoding occurs when information from the outside world reaches our senses in the forms of chemical and physical stimuli. In this first stage the information is changed so that memory can start encoding process. The second stage of memory is storage. This requires that we sustain information over periods of time. Finally, the third process is the retrieval of information that was stored. The information must be located and returned to the consciousness.

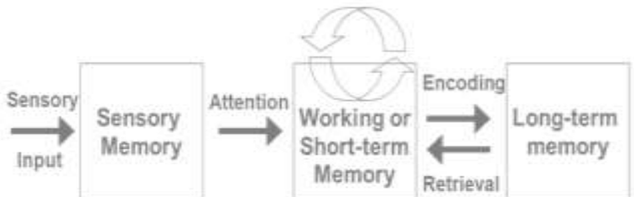

Figure 1: Working Memory Model

Working memory is the system that actively holds multiple pieces of transitory information in the mind, where they can be manipulated. Working memory is commonly used synonymously with short term memory, but this depends on how the two systems of memory are defined [1]. Working memory includes subsystems that store and operates on visual images or verbal data, as well as a central executive that coordinates the subsystems. It includes visual representation of the possible moves, and awareness of the flow of information into and out of memory, all stored for a limited amount of time [2]. The cognitive processes needed to achieve this include the executive and attention control of short - term memory, which permits temporary integration, processing, removal, and retrieval of information. These processes are dependent on age and are susceptible to age related changes: working memory is associated with cognitive development, and research shows that its capacity recedes with old age.

Working memory is one of the cognitive components which is the most sensitive to decline as age increases. [3], [4] Several explanations have been offered for this decline in psychology.

Working memory is made up of three components (see Figure 2):

1) The central executive - the part of the system responsible for processing information
2) The phonological loop - responsible for the temporary storage of verbal information.
3) The visuo - spatial scratch - pad - accountable for the brief storage of visual and spatial information.

Figure 2: Working Memory Model. [5]

Working memory can be strengthened by working on any of these individually or in coherence.

To test this, a longitudinal study was conducted to access the impact of visuospatial stimulation through the use of jigsaw puzzle on verbal working memory as reflected by digit span.

2. Method and Procedure

The sample comprised of 32 adults with minimum ability to recognise numbers, cleaved in two groups, and are able to follow basic instruction with the age range of 20 - 25 yrs (M=23, SD=1.6) as young adults in group I and above 60 (M=64, SD=3.6) older adults in group II. Each groups had equal number of participants (*n* = 16). Participants scoring more than or equal to 25 on the HMSE were included in this study. The participants were asked to verbally repeat a set of digits in same sequence as the examiner in DFS task, and in reverse order for DBS task. Test begins from a set of 2 digits continuing to a maximum set of 7 digits. Each set was tried thrice. Digits were presented at a rate of a single digit per second. VWM span was calculated as a set of maximum digits, where two out of three trials were repeated correctly.

The digit span task was performed before the stimulation of jigsaw puzzles practice as pre - evaluation of verbal working memory, then the post evaluation was also obtained a period of 9 session practice as post evaluation with practice of jigsaw puzzles and then again after 10 days digit span task was performed to check the sustainability of changes occurred in digit span as changes in verbal working memory.

3. Results and Discussion

Mean (fig 3) and standard deviation (SD) of verbal Working memory span (Digit forward span & Digit backward span) pre training evaluation, immediate post training evaluation and latency of 10 days post training are shown in Table 1 and Table 2 for both the groups. Group I digit span was higher than Group II digit span across both age groups and Digit forward span for immediate post training scores was higher than Digit forward span for pre training scores and Digit forward span latency of 10 days post training scores also Digit backward span for immediate post training scores was higher than Digit backward span for pre training scores and Digit backward span latency of 10 days post training. In both the groups though it was found that mean of period of sustained recovery was less than the mean of post training but still slightly better scores was observed of period of sustained recovery from the pre training evaluation in Digit forward span and Digit backward span as shown in fig 3 (table 1 & 2).

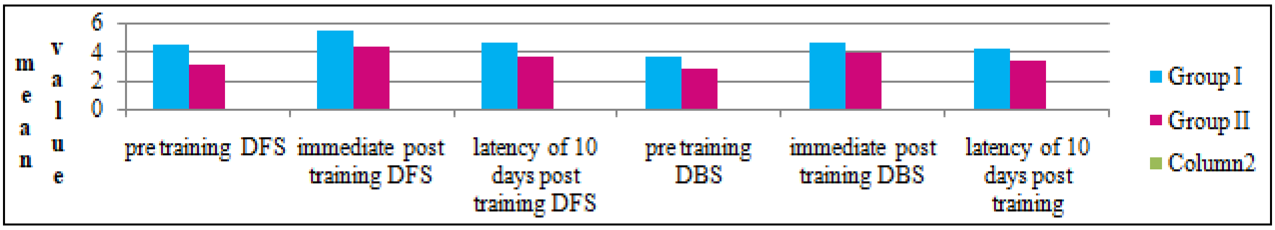

Figure 3: Mean value of verbal working memory in both groups

Table 1: Mean and Standard Deviation of pre training evaluation, immediate post training evaluation and latency of 10 days post training for forward span in both groups

	Mean	*Sd*
Group I pre training DFS	4.5000	.51640
Group II pre training DFS	3.1875	.83417
Group I immediate post training DFS	5.5625	.51235
Group II immediate post training DFS	4.4375	.62915
Group I latency of 10 days post training DFS	4.6875	.60208
Group II latency of 10 days post training DFS	3.7500	.68313

Table 2: Mean and Standard Deviation of pre training evaluation, immediate post training evaluation and latency of 10 days post training for backward span in both groups

	Mean	*Sd*
Group I pre training DBS	3.6875	.60208
Group II pre training DBS	2.8750	.61914
Group I immediate post training DBS	4.7500	.57735
Group II immediate post training DBS	3.9375	.44253
Group I latency of 10 days post training DBS	4.2500	.77460
Group II latency of 10 days post training DBS	3.4375	.51235

Paired sample 't' test was performed to compare the significance difference with in the both groups, and found pre training scores vs immediate post training scores, post training scores vs latency of 10 days post training scores for Digit forward span and Digit backward span in both groups as shown in table 4, p value 0.000 for group I pre training scores Digit forward span vs group I immediate post training scores Digit forward span, p value.000 for group I immediate post training scores Digit forward span vs group I latency of 10 days post training scores Digit forward span, p value.000 for group I pre training scores Digit backward span vs group I immediate post training scores Digit backward span, p value.002 for group I immediate post training scores vs group I latency of 10 days post training Digit backward span, p value .000 for group II pre training scores Digit forward span vs group II immediate post training scores Digit forward span, p value.000 for group II immediate post training scores Digit forward span vs group II latency of 10 days post training scores Digit forward span, p value.000for group II pre training scores Digit backward span vs group II immediate post training scores Digit backward span and p value.002 for group II immediate post training scores vs group II latency of 10 days post training scores Digit backward span. These all pair of analysis show significant difference as p value is <0.05 as show in table 3.

Table 3: Paired 't' test for pre, immediate post and latency of 10 days post training scores within the both Groups

Pairs	*Mean*	*Sd*	*T*	*Sig (p)*
G - I pre DFS vs G - I immediate post DFS	-1.06250	.25000	-17.000	.000
G - I immediate post DFS vs G - I latency of 10 days post training DFS	.87500	.34157	10.247	.000
G - I pre - DBS vs G - I immediate post DBS	- 1.06250	.25000	-17.000	.000

G - I immediate post DBS vs G - I latency of 10 days post training DBS	.50000	.51640	3.873	.002
G - II pre DFS vs G - II immediate post DFS	-1.25000	.57735	-8.660	.000
G - II immediate post DFS vs G - II latency of 10 days post training DFS	.68750	.60208	4.568	.000
G - II pre - DBS vs G - II immediate post DBS	-1.06250	.44253	-9.604	.000
G - II immediate post DBS vs G - II latency of 10 days post training DBS	.50000	.51640	3.873	.002

*p < 0.05 = significant difference; **p<0.01 = highly significant difference.

ANOVA was performed to compare pre training and immediate post training evaluation for Digit forward span and Digit backward span across the two groups respectively which yielded a p value of 0.000for pre training Digit forward span and a p value of 0.001 for pre training Digit backward span and a p value of 0.000 for immediate post training Digit forward span, a p value of 0.000 for immediate post training Digit backward span which shows significant difference as the p vale is <0.05, as shown in table 4.

Table 4: ANOVA for pre training (Digit forward span and Digit backward span) and immediate post training (Digit forward span and Digit backward span) in both groups

Groups	*F*	*Sig.*
Pre training DFS for group I and group II	28.636	.000
Pre training DBS for group I and group II	14.162	.001
Immediate post training DFS for group I and group II	30.759	.000
Immediate post training DBS for group I and group II	19.961	.000

*p < 0.05 = significant difference; **p<0.01 = highly significant difference.

4. Conclusion

The results of this study present some important evidences. Normal aging affect both the aspects of verbal working memory i.e., forward and backward in relation to young adults. Both domains of verbal working memory (forward and backward span) declines in aged population when compared to young adults. Also note practice of visuo - spatial stimulation has improvement in verbal working memory. There was significant difference between pre - evaluation and post evaluation after some amount of practice in digit forward and backward verbal Working Memory span in both groups. Also, there was significant difference between post evaluation and sustenance after 10th day evaluation in digit forward and backward verbal Working Memory span in both groups.

5. Potential usage in the field of Intellectual disabilities

Theoretically this can be used to rehabilitate children with Down syndrome, as they have a specific impairment in short - term memory for verbal information (i. e., the phonological loop) and this will make processing verbal information and, therefore, learning from listening, specifically difficult for them. Their visual - spatial short - term memory is ahead than verbal memory, making the ability to learn from visual information a relative strength. This can (and should) be used to support weaker verbal processing abilities. [6] Developing working memory skills for children with Down syndrome).

6. Author Contribution

Ms. Ritika Singh came up with the idea of the research the data collection was done equally by both the authors, Mr. Bhowmick Kandpal wrote the initial draft of the paper.

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Author Profile

Ritika Singh Completed her BASLP from Helen Keller's institute of research and rehabilitation and MASLP from AYHNIHH, SRC. During 2015 - 2016she worked at My ear cochlear implant and hearing aid clinic, Bhopal as Clinical Audiologist and SLP. In2016 - 17sheworkedas an Audiologist under the NPPCD program at SSJ Base hospital Haldwani. She then worked at The Institute of Health Sciences, Bhubaneswar, as Assistant Professor Department of Speech language pathology. She was actively involved in academics, pursuits of teaching, practicing and research in ASLP. Now she is working as Senior Audiologist and Speech Language Pathologist, Srajan Spastic Society, Haldwani.

Bhowmick Kandpal completed his BASLP from Sweekaar Academy of Rehabilitation Sciences and MASLP from AYHNIHH, SRC. During 2015 - 2016 he worked at Srajan Spastic Society, Haldwani as an Audiologist cum Speech Therapist. In2016 - 17heworkedas an Audiologist under the NPPCD program at JLN district hospital Rudrapur. He is now working at The Institute of Health Sciences, Bhubaneswar, as Assistant Professor and HOD department of Audiology. He is actively involved in academics, pursuits of teaching, practicing and research in Audiology.