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WORKING MEMORY AND ACADEMIC ACHIEVEMENT IN CHILDREN WITH MILD INTELLECTUAL DISABILITY

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ABSTRACT

The aim of the study to assess the three original working memory (WM) component and academic achievement in children with mild intellectual disability. A Battery of working memory and academic achievement test administered to (MA-7.32 to 11.40) Children mild intellectual disability (CWMID) and mental age (MA-8.20 to 12.80) matched typically develop (TD) children. Results revealed that typically developed mental age matched children performed significantly better than children with mild Intellectual disability in visual spatial memory (VSSTM) and central executive loaded working memory (CELWM). There was significant relationship between VSSST and Mathematics in TD children and among CWMID PSTM was significantly correlated with Mathematics. A Strategic model can be prepared for the intervention of weak WM components to improve the academic achievement of children.

KEYWORDS: *working memory, temporary storage, maintenance,*

INTRODUCTION

Intellectual disability characterises limitations in intellectual functioning and adaptive behaviour. It covers both everyday social and practical skills. The disability originates before the age of 18 (AAIDD, 2010). Intelligence quotient of children with mild intellectual disability (CWMID) ranges from 50 to 69. (Weiner, 2003). Deficit in working memory is evident in CWMID (Van der Molen, et.al 2007). Working memory (WM) refers to the active maintenance and parallel processing of information (Christopher Jarrold & Brock, 2012). Several models have been put forward to explain functioning of working memory. One of the prominent and well-studied model is of 'Baddeley'. Baddeley's Model explains working memory using four components : a phonological loop responsible for the temporary storage of verbal/speech based information (Phonological Short Term Memory, PSTM); a visuo-spatial sketchpad to temporary hold and maintain visuo-spatial information (Visual Spatial Short term Memory, VSSTM); a central executive to provide overall attention control of the working memory system which is called as central executive loaded working memory (CELWM) and an episodic buffer, which contributes modality free storage as well as link to long term semantic and long term knowledge (Beddeley & Hitch 1974; Baddely 2000, 2007). This Model helps to assess working memory of both TD children and children's with intellectual disabilities (ID). Children with down syndrome has shown more problems with PSTM and individual with William syndrome has found problem in VSSTM (Alloway, Gathercole, & Pickering, 2006). L. A. Henry & MacLean (2002) examine the WM in children with

Intellectual disabilities (ID) aged 11-12 years which were compared with the typically developed children of same chronological age (CA) and the mental age. This study found that CWID performed poorly than children matched for CA in all span task and they were clearly found weak in word span. Previous studies have found that working memory components are strong predictor of academic achievement (L. Henry & Winfield, 2010). But very less evidence are available in children with MID. The aim of our study is to compare CWMID with mental age matched children TD and academic achievement.

METHOD

Participant:-

The study group consisted total 15 participants (Mean=115.8months, SD= ±19.86), which were divided into two groups. Group one had 8 typically developed children, whereas, group two consisted 7 intellectually disabled children. Description of the group is given in the table 1.

Table 1. Descriptive statistics of Sample

Group	Mean Mental age	Mean chronological age	Mean IQ	Std. deviation Mental age	SD chronological age	SD IQ
TD	123.00	112.5	108.81	±20.43	±10.99	±13.11
ID	107.71	172.42	63.00	±16.97	±28.62	±3.46
Total	115.86	140.46	87.43	±19.86	±25.51	±25.51

SD= standard deviation; IQ= Intelligent Quotient

IQ was taken as the composite score of the scores obtained by the subject on "Draw A Man Test", and IQ obtained through the institute. Data was obtained through purposive sampling and the mental ages of the participants were matched in both groups. All the children were taken from the normal and special schools of Mysore, Karnatka. All the children were tested individually in their schools. Prior permission was taken from the schools at which study was carried out.

Procedure –

Tools

A working memory battery was compiled out of taking different memory tasks according to the working memory model from Indian standardized tests. Only Three tests were taken from the outside India. Detailed explanation of all these memory tasks is given below.

Phonological Short Term Memory – Two tests were used to assess the phonological short term memory: a digit span (DS) and syllable span (SP) test (Bhatia Battery). Reliability and validity co-efficient were for these tests 0.84 and 0.71. The digit and the syllable span tasks varying 8 levels of difficulties. In both the tasks, the participant has to immediately repeat digits or Hindi syllables verbally in exactly the same order as presented at the rate of one per second. Span score will be calculated based on the longest list recalled correctly. There were three tests trails at each list length. As long as the participants passed two trials, they were taken in to the next level of digit or Hindi syllable list.

Visual- Spatial Short Term Memory – Two tests were used to assess the visual-spatial short term memory:-

Abstract Figure Short Term Memory Span (AFSTMS) - This task was taken from the Indian Child Intelligence Test, 2005. In this task abstract picture which can't be named shown in an order from level two of pictures to level of seven pictures. Child had to see the pictures for 5 seconds and keep in mind the order of the picture. Then after arrange the jumbled picture cards in the same array which the participant had seen in the picture book. In this task longer list lengths are increased the difficulty of task. Span score was calculated based on the longest list recalled correctly.

Spatial Short Term Memory Span (SSTMS) – This task is based on the corsi-block Tapping task. In this task, the experimenter pointed to a series of line drawing cubes which are randomly in different spatial locations on A4-sized paper and the participant must point to the same drawings in the same order. Test start with pointing on two cubes and maximum was up to 8. There were two trials at each level. To move to the next level participant must complete one trial out of two. Span is measured as the longest sequence pointed.

Central Executive Loaded (CELWM) Three tests were administered to assess CELWM.

Listening Span (Henry, L.A 2011): The test was translated and retranslated in Hindi with help of four experts in the field of Psychology, Special Education, Educational Psychology and Linguistic. We took prior consent from main author to translate the test. It contains different short sentence that would either be true or false (e.g. "Log Chal Sakte hai" or " Fool gaa sakte hai"). This varies at four levels of difficulties each of which were tested by two different trials. Sentence-first words must be recalled in any order on this task. Listening span score was the longest list length at which two trials were passed.

Odd One Out Span Task (Henry, L.A 2013): It involves various sheet with shapes and symbols

and response sheet. Each sheet contains three shapes or symbols. Out of three shapes or symbols two were identical and third was slightly different from other two shapes or symbols (odd one out). Response sheets involve blank elongated rectangular boxes divided into three sections from left to right. These blank boxes were corresponding to the odd one shapes. This varies at five levels of difficulties, each of which was tested by two different trials. It was pointed out that each figure corresponded the one section in the blank box. Figures were black & white line drawings of various shape and symbols. Child was provided with practice trial and after passing two trials next level was given. Odd one out span score was the longest list length at which two trials were passed.

Reverse digit span task (RDS): This task is similar to the digit span task but way of the response on this task is reverse. Span score was the longest list length correctly recalled.

Academic Achievement – In this study, academic achievement refers to marks obtained by children with Intellectual disability in mathematics and Hindi subject in Grade Level Assessment (Narayan, 2003).

RESULTS

Reliability and validity of the working memory task –All of the working memory task having been used in the previous research measuring working -memory components (Phonological short term memory, Visual-Spatial short term memory and central executive loaded working memory) (L. A. Henry & MacLean, 2002; L. Henry & Winfield, 2010; Lucy Henry & MacLean, 2003). But there are very few researches using sample of children mild intellectual disability. Therefore researcher presented some evidence for construct validity of the span task.

*- Sig at .05 level ** - Sig at.01 level. DSF- Digit Forward Span, SP- Syllable Span, AFSTM- Abstract figure short term memory test, SSTM- Spatial sort term memory test, LST – Listening Span test, OOO – Odd one out, RDs – Reverse Digit Span.

Table 2 - Correlation coefficient between all WM measures

	DSF	SP	AFSTMS	SSTMS	LST	OOO	RDS
DSF	1						
SP	.630**	1					
	.006						
AFSTMS	.575*	.232	1				
	.012	.203					
SSTMS	.430	.603**	.608**	1			
	.055	.009	.008				
LST	.452*	.367	.475*	.523*	1		
	.045	.089	.037	.023			
OOO	.451*	.442*	.516*	.737**	.480*	1	
	.046	.050	.024	.001	.035		
RDS	.542*	.395	.616**	.645**	.622**	.905**	1
	.018	.072	.007	.005	.007	.000	

Correlation between the span tasks are given in Table 2. The span task of phonological short term memory (DSF, SP), Visual- Spatial Short term memory (AFST, SSTMS), Executive loaded working memory (LST, OOO, and RDS) were strongly correlated. Reliability Coefficient (Cronbach's Alpha) of seven item of WM battery was .88 which is very good to for internal consistency of tool. Working memory between TD and ID children: The distribution of CE differed significantly (U=10, p=.04) across the groups. CE of TD (Mdn =8) was significantly higher than ID (Mdn = 5) children. Similarly, VSSTM was also significantly higher for TD (Mdn = 8) as compared to ID (Mdn = 5) children (U= 7.5, p = .014). However, we did not find any significant distribution of PL between the groups (U=22, p=.53).

Correlation between WM and Academic achievement of TD and ID children: The researcher took two components of academic achievement, Hindi and Mathematics to find out the correlation with three components of working memory (PSTM, VSSTM, CELWM). TD children showed significant correlation between VSTM and mathematics score (r= .655, p= .03). There wasn't any significant correlation between other components of working memory and academic achievement in case of TD children. Children with ID shown significant

correlation between PSTM and mathematics score (r= .764, p= .023) but did not show any significant correlation in any of the components.

DISCUSSION

Results has shown that typically developed mental age matched children performed significantly better than children with mild Intellectual disability in visual spatial memory and central executive loaded working memory . Supporting study (Marinosson, 1974) found that Children with MID achieved lower score in visual short term memory. However in contradictory studies (L. A. Henry & MacLean, 2002; Marinosson, 1974) children with ID obtained higher score in visual- spatial short term memory then the metal age matched typically developed children. Four studies found the similar scores in VSSSTM (Baddeley & Jarrold, 2007; C. Jarrold, Baddeley, & Hewes, 1999; Martin, West, Cull, & Adams, 2000; Schuchardt, Gebhardt, & Mäehler, 2010). Whereas supporting study for significant difference in CELWM in Children with ID and mental age matched typically developed children (Bayliss, Jarrold, Baddeley, & Leigh, 2005; Cornoldi & Vecchi, 2004; Van der Molen, Van Luit, Jongmans, & Van der Molen, 2009; "Working Memory in Children with Autism and with Moderate Learning Difficulties - Russell - 2006 - Journal of Child Psychology and Psychiatry - Wiley Online Library," n.d.) found ELWM problem in Children with ID. But (L. A. Henry & MacLean, 2002) found children with ID performance was slightly above than mental age matched typically developed children. It's difficult to conclude whether performance of children with ID and mental age matched group were equal, better or lesser because there is no consistency in previous. It may be because of methodological variations.

Results have shown that there is role of visual-spatial short term memory in mathematic subject in typically developed. Supporting studies (Holmes & Adams, 2006; McLean & Hitch, 1999; Rasmussen & Bisanz, 2005) found visual-spatial component of working memory as the best predictor of the maths. In CWMID we found that PSTM played positive role in mathematics. Mathematics problems are attributed to PSTM because for basic calculation PSTM is required to store and then process. Supporting studies (Holmes & Adams, 2006; Lee & Beebe-Frankenberger, 2004; Swanson & Sachse-Lee, 2001) concluded that PSTM may not be so important like other memory processes but it has unique contribution in mathematics. Development of working memory and its relationship may not have much difference because methodological variance. Future studies may be longitudinal in nature to find the accurate relationship between WM and Academic achievement. Small sample is the limitation of this study. Large sample size with matching of group is also required to have large generalization of the results.

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