Man In India, 96 (6) : 1845-1852

WORKING MEMORY IN CHILDREN WITH DOWN SYNDROME

Shaznee Iryana Bt Yusoff and Yeo Kee Jiar

The Down Syndrome (DS) or Trisomy 21 is a common chromosome disorder which has an extra chromosome on the 21st pair resulted in impairments and limitations in developmental abilities and physical growth. Memory is one of the vital features of deficits in cognitive development in Down syndrome. Working memory refers to the capacity to store and manipulate information for brief period of time. It is a cognitive system required for various cognitive tasks. The sample of this study consisted of forty 6-14 years old children and adolescents with Down syndrome who scores at or below the 15th centile on listening recall and backward digit recalls (two subtests from AWMA) within the Kuala Lumpur district. Prerequisite requirements (no physical and sensory impairment) were met. The tool that had being used to assess the level of working memory in children and adolescents with Down syndrome is the Automated Working Memory Assessment (AWMA), a cognitive- based measure of working memory. Result showed that children with Down syndrome achieved highest score in visuo- spatial working memory (M=69.9) followed by verbal working memory (M=68.5), verbal short term memory (M=66.62) and visuo- spatial short term memory (M=62.02).

INTRODUCTION

Down syndrome, characterized by cognitive impairment, a number of physical characteristics such as small chin, slanted eyes, poor muscle tone, and a flat nasal bridge, Mongoloid- like facial and multiple deformities. The Down Syndrome (DS) or Trisomy 21 is a common chromosome disorder which has an extra chromosome on the 21st pair resulted in impairments and limitations in developmental abilities and physical growth as compared to normal children. Roughly, 1 in 700 to 800 live births (Sherman *et al.*, 2007; Centers for Disease Control & Prevention, 2006) in western countries showed the incidence of Down syndrome while the total number of worldwide is more than 200,000 cases per year (Christianson *et al.,* 2006). A survey conducted in a Maternity Hospital, Kuala Lumpur showed that the incidence of Down syndrome was 1:959 live births. The incidence of this chromosome disorder within the three major ethnics in Malaysia is 1:987 in Malay, 1:940 in Chinese and 1;860 in Indian (Hoe *et al.,* 1989). Most individuals with Down syndrome have an IQ ranging from mild (IQ 50-70) to moderate (IQ 35-50) (Naess *et al.,* 2011) and they are believed to be slow learners. Since it is commonly associated with mental retardation, impairments in the growth of cognitive development are inevitable.

Address for communication: **Shaznee Iryana Bt. Yusoff**, Doctor of Philosophy (Educational Psychology), Department of Educational Psychology, University Technology Malaysia, Johor, Malaysia, *E-mail: shazneeyusoff@gmail.com*

Memory is one of the core features of impairments in cognitive development in Down Syndrome. Albeit being able to perceive information accurately they are impeded in their ability to interpret and use this information. This is possible due to their impotence in operating their executive function, an attention control system responsible for manipulating information. Limitations in memory span especially in processing verbal information will result to a poor language and learning outcome (Byrne *et al.,* 1995). Multiple deficits have been identified in short-term memory and the peripheral systems of articulatory rehearsal as well as central systems that direct the information processing seem to be deficit in these individuals (Hulme and Mackenzie, 1992).

LITERATURE REVIEW

In this section, the term working memory is explained and overviews of past studies on working memory are discussed. Objective of this study is also included.

WORKING MEMORY

The term 'working memory' refers to the capacity to store and manipulate information for brief period of time. It provides a mental workspace that is used in many important activities in everyday life. Working memory is a pure measure of a child's learning potential. It is not strongly influenced by the child's prior experiences such as pre- school education or their socio-economic background (eg., maternal educational level), it tells us a child's capacity to learn. Working memory is a cognitive system used for short-term storage and manipulation of information required for various cognitive tasks. Short- term memory holds both verbal and visual information, only then would it transfer it to the working memory which can manipulate information (Baddeley , 1992). This is due to the existence of the central executive (an attention control system) in working memory system that regulates and manipulates information.

Baddeley and Hitch (1974) introduced the renown working memory model which involves a central executive which is an attention control system responsible for manipulating information, a phonological loop for maintaining and rehearsing verbal information, and a visual-spatial sketchpad for storing visual–spatial information (see Baddeley and Logie, 1999, for a review). Baddeley then revised this model to include an episodic buffer, which is thought to be a multi-modal system that integrates memory across domains (visual, spatial, verbal, etc.) into scenes or episodes. Episodic buffer within working memory seems to play an important part in the working memory system as Baddeley insisted on revising it. (Baddeley, 2000).

Possible impairment in the verbal component of working memory system had been shown in a number of studies of working memory in Down syndrome while visuo-spatial is found fairly unaffected (Hulme and Mackenzie, 1992; Jarold and Baddeley, 1997, 2001: Jarrold, Baddeley and Hewes, 2000; Lanfranci, Cornoldi and Vianello, 2004; Wang and Bellugi, 1994). Moreover, Lanfranci et al. (2004) found that different scores increases on working memory tasks among children with Down syndrome and typically developing children matched on mental age as the tasks require more involvement of central executive. Previously, a similar finding was found by Vicari, Carlesimo and Caltagirone (1995). This prompt a hypothesis that both verbal and control (central executive) components in working memory are impaired. Conversely, verbal working memory deficit seems to be Down syndrome specific. It was reported that there is no verbal working memory deficit in individuals with William syndrome (Wang and Bellugi, 1994) or in Fragile X-syndrome (Lanfranci *et al.,* 2009).

However, Jarold and Baddeley (1997); Marcell and Armstrong (1982), and Marcell, Harvey and Cothran (1988) showed that verbal working memory deficit does not draw a parallel with hearing difficulties and difficulties in articulation (Jarold, Baddeley and Hewes (2000), Marcell and Weeks (1988). According to Vianello (2006), overall verbal impairment is the key reason that can cause deficit in verbal working memory in individuals with Down syndrome.

OBJECTIVES

The main objective of this study is to find the level of working memory in children with Down syndrome.

METHOD

In this section, the subjects and the measures used for working memory assessment will be described.

SUBJECTS

The sample of this study consisted of 6-14 years old children and adolescents with Down syndrome within the Kuala Lumpur district. Both gender, (male and female) were involved and prerequisite requirements (no physical and sensory impairment) were met. Later on, a total of 40 DS children and adolescents who scores at or below the 15^{th} centile on listening recall and backward digit recall (two subtests from AWMA) (Holmes *et al.,* 2009) were screened with from twelve schools within the Keramat region.

MEASURES

The Automated Working Memory Assessment, a cognitive- based measure of working memory is being used as a tool to assess the level of working memory in children and adolescents with Down syndrome. Developed by Alloway (2007), it is a computer- based assessment of working memory skills, with a user- friendly interface. This culture- fair tool provides a practical and convenient way for educational professionals to screen individuals for significant working memory problems. It is standardized for use with individuals from early childhood (4 years) to (adulthood (22 years). Three measures each of the verbal and visuo-spatial aspects of short-term memory and working memory were tapped by the AWMA. Subtests such as digit recall, word recall and non-words recall are being used to measure the verbal short- term memory. Subtests such as dot matrix and block recall are being used to measure the visuo- spatial short- term memory domain. On the other hand, the verbal and visuo- spatial working memory were measured using tasks involving simultaneous storage and processing of information. Subtests such as listening recall and backwards digit recall are being used to measure the verbal working memory. Subtests such as odd one out, spatial recall and Mister X are being used to measure the visuo- spatial working memory. More complex tasks have been designed to measure the central executive aspect of working memory. Subtest such as counting recall where the participant counts the number of target items in each of a series of successive arrays and then recalls the totals for each array in the original sequence (Case, Kurland, and Goldberg, 1982).

RESULTS

Student's gender and age are reflected in descriptive statistics while the level of working memory in Down syndrome children is shown through the mean composite score of working memory. In order to calculate composite scores the standard scores of the subtests in each memory component are summed and then standardized. Standard scores are a way of describing an individual's performance with respect to the performance of others in the same age band.

GENDER AND AGE

Descriptive analysis of student's gender showed that there are 24 male students and only 16 female students had participated in this study. The mean age is 10.35 with a standard deviation of 1.777. The minimum age is 6 years old while the maximum age is 13 years old. Student of age 10 is the highest number of participant with a frequency of 10. There is only one student aged 6 years old.

LEVEL OF WORKING MEMORY

Result showed that children with Down syndrome achieved highest score in visuo-spatial working memory (VSWM) (M=69.9, SD=9.018) compared to other working memory domains, followed by verbal working memory (VWM) (M=68.5, SD=5.023), verbal short term memory (VSTM) (M=66.62, SD=5.714) and visuo-spatial short term memory (VSSTM) (M=62.02, SD=8.081).

DISCUSSION

This study showed the level of working memory in children with Down syndrome according to their domain respectively. The finding in this study is consistent with the previous studies, which said that the verbal component of working memory in Down Syndrome is more prone to be impaired rather than the visuo- spatial component of working memory. With the score of M=69.9, visuo- spatial working memory (VSWM) showed the highest mean score compared to other working memory domains. Possible impairment in the verbal component of working memory system has been shown in a number of studies of working memory in Down syndrome while visuo-spatial is found fairly unaffected (Hulme and Mackenzie, 1992; Jarold and Baddeley, 1997, 2001: Jarrold, Baddeley and Hewes, 2000; Lanfranci, Cornoldi and Vianello, 2004: Wang and Bellugi, 1994). However, Lanfranci et al. (2009) found that individuals with Down syndrome are poorer than controls in the spatial-simultaneous tasks (working memory), but not in the spatial-sequential tasks (short-term memory). In the mean time, verbal working memory deficit seems to be Down syndrome specific. It was reported that there is no verbal working memory deficit in individuals with William Syndrome (Wang and Bellugi, 1994) or in Fragile X- syndrome (Lanfranci and Vianello, 2009).

CONCLUSION AND FUTURE STUDY

In a nutshell, children with Down syndrome in this study showed the highest mean score in visuo- spatial working memory. For future study, an intervention program should be develop using this finding in order to increase the memory ability of children with Down syndrome.

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ANNEXURE A

TABLE 1: DESCRIPTIVE STATISTICS OF STUDENT'S GENDER

	Gender	
	N	*%*
Male	24	60
Female	16	40
Total	40	100

ANNEXURE B

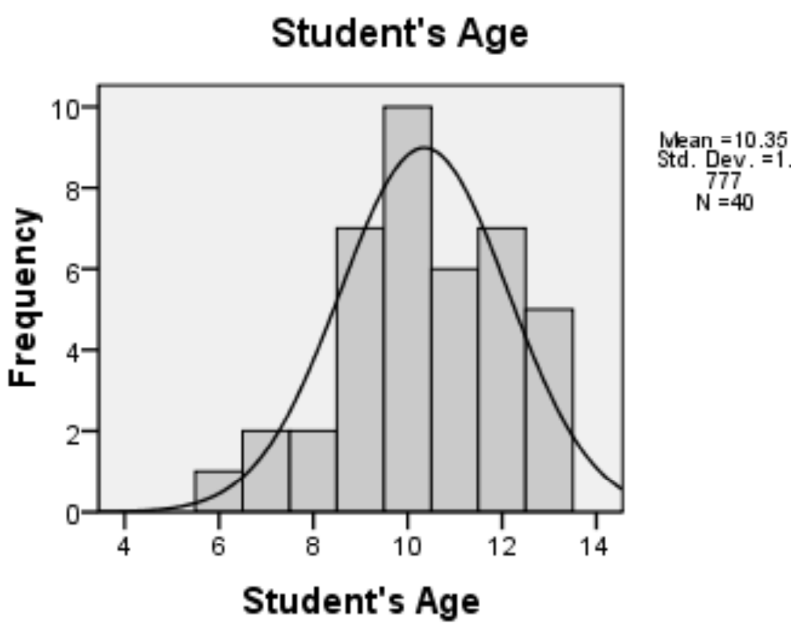

Figure 1: The frequency of student's age

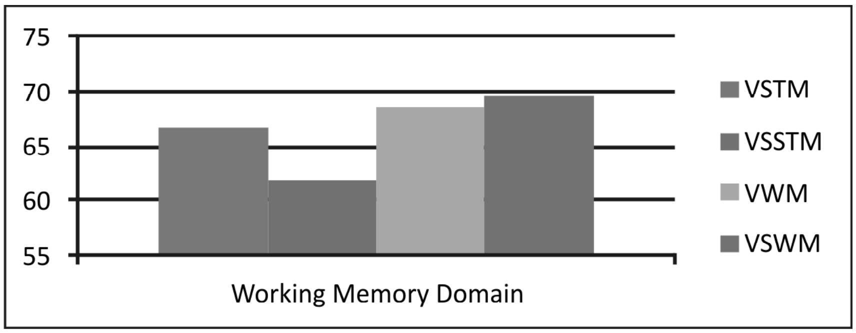

Figure 2: The mean score of working memory (composite score)