Memory functioning in post-secondary students with learning disabilities

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ABSTRACT

Working memory is a core psychological process. Deficits in working memory have been shown to be related to performance in academic tasks including literacy and mathematics. A limited-capacity working memory system has been shown to underlie some academic difficulties presented by children with diagnosed learning disabilities. Although similar findings have been found for adults with learning disabilities, less research has been conducted with this population. The current study examined 107 adults who were pursuing post-secondary schooling. The subjects were referred by career counselors who suspected them to have undiagnosed learning disabilities. Subjects underwent a cross-battery including assessment of intellectual, achievement, and verbal learning and memory. All subjects met the criterion for a learning disability according to the DSM-IV. After controlling for full-scale IQ, analyses revealed significant partial correlations ($p<0.05$) between working memory, verbal learning and memory, and reading comprehension. Results from regression analysis indicated that working memory was a significant predictor of reading comprehension. Findings provide corroborating evidence of working and auditory memory deficits in adults with learning disabilities.

Key words: learning disabilities, working memory, verbal memory, adult education

INTRODUCTION

Recent history indicates that there are an increasing number of individuals with learning disabilities (LD) attending institutions of higher education. Surveys among college students indicate between 2% to 4% report having a learning disability including those attending professional programs (Sack et. al, 2008). The American Council on Education reported the number of students with learning disabilities entering college increased significantly from 1978 to 1991 (American Council on Education, 1995) and recent reports continue to suggest that this trend continues (Gregg, 2007). The growing number of students with LD attending higher education is likely related to the important socio-political changes within the last decades that have helped provide supports for students with LD in addition to breaking down the perceived barriers for these individuals.

The demands of higher education are significant for all students and various studies have described the specific academic barriers that face students with LD. For instance, organization and managing time demands are a vital aspect of college life and students with LD show difficulties in their ability to adjust to these demands (Braxton, Milem & Sullivan, 2000; Gans, Kenny & Ghani, 2003). In addition, they appear to take longer to adjust to the challenges of higher education (Greenbaum, Graham, & Scales, 1996). Procrastination is a common issue for students within higher education and select studies suggest that students with LD are more prone to procrastinate and ruminate about initiating work activity (Klassen et al, 2008). There is also a higher incidence of mental health concerns and diagnoses among this population (Wilson et. al., 2009; Mrazik et. al. 2009). In contrast, students with LD reported more social acceptance and support (Cosden & McNamara, 1997) than their peers and some students show a stronger awareness and openness to seeking and using available resources (Raskind et al, 1999). Various meta-analytic and confirmatory factor analytic studies have identified the "double deficit hypothesis" in lexical retrieval and phonetic awareness in individuals with LD (Birch & Chase, 2004). This has implications for interventions and strategies directed at improving reading and reading fluency. A lesser understood dimension of LD relates to verbal learning and memory difficulties. Several studies have identified verbal working memory deficits as contributing independently to reading comprehension weakness in students with LD (Katz, Golstein & Beers, 2001; Ransby & Swanson, 2003). Several studies have considered working memory deficits in children (Swanson & Seigal, 2001) or adolescents (Ranby & Swanson, 2003; Sterr, 2004) but there have been few studies directed towards adults, especially those attending post-secondary schooling. The importance of an efficient auditory memory system for students is vital given that the majority of instruction in college is presented orally.

For all students of higher education, verbal working memory and verbal learning play a key role in global cognitive functioning. For instance, Reber & Kotovsky (1997) found that taxing the working memory system was related to difficulties learning to solve problems. Specific to individuals with LD, one study explored differences between students with LD compared to those without LD in terms of reported reasons subjects felt they experienced difficulties in post-secondary schooling (Heiman, 2003). Results suggested that a significantly higher number of LD students reported problems with

memory than students without LD. This translated into more global academic difficulties.

The importance of an efficient memory system cannot be understated, especially for students attending post-secondary institutions. It was the purpose of this study to investigate cognitive variables of auditory learning and memory. Specifically, our study sought to examine adults attending post-secondary schooling who were diagnosed with LD. All subjects underwent a comprehensive cross-section battery of psychological tests including measures of working memory, verbal learning and memory, and reading comprehension. Results of testing sought to identify specific cognitive processes that may account for difficulties students with LD have with learning. It was hypothesized that students with LD would demonstrate poorer performance on measures of working memory, verbal learning and memory, as well as reading comprehension.

SUBJECTS AND PROCEDURES

One hundred and seventeen adults (mean age = 27.73 SD = 8.75) were evaluated at a university outpatient education clinic. All subjects were referred by a career counselor who either suspected subjects to have an undiagnosed LD or who had a previous diagnosis of a LD. All subjects were students enrolled in a post-secondary education program (mean education = 12.11, SD = 1.9) in the province of Alberta, Canada. To be eligible for learning and test accommodations at their post-secondary institution, participants were required to undergo a comprehensive psycho-educational assessment including a detailed clinical interview. All subjects provided written consent to participate in the assessment. Subjects included students who were diagnosed with a learning disorder (in reading or written expression) according to the DSM-IV criterion. Seven subjects were eliminated from the study as a result of a concurrent diagnosis and treatment of a psychiatric illness. Three subjects were also eliminated because of a reported history of a severe traumatic brain injury.

INSTRUMENTS

The assessment battery included the Wechsler Adult Intelligence Scale, 3rd Edition (Wechsler, 1997), Woodcock Johnson Test of Achievement, 3rd Edition (Woodcock, McGrew & Mather, 1989), and California Verbal Learning Test, 2nd Edition (Delis et. al, 2000). Results from other measures included in the cross-battery assessment (complex visual attention, and executive decision making) were not included in this study. Scores from the WAIS-3 and WJ-3 were reported as standard scores (mean = 100, SD = 15). Results from the CVLT-2 were presented as z-scores for individual subtest/index scores (mean = 0, SD = 1) and as a t-score for total learning score (mean = 50, SD = 10).

RESULTS

Descriptive statistics are provided in Table 1. For students with LD, global performance on measures of intellectual functioning fell within the educational description of the average range (mean = 93.80, SD = 14.01), with subjects showing a

slight but non significant advantage of performance intelligence compared with verbal intelligence. Analysis of the four index scores comprising the WAIS-3 indicate subjects had their lowest performance on the Working Memory Index (WMI) with mean scores falling at approximately the 25th percentile (approximately two-thirds of a standard deviation below the norm). Subjects also demonstrated lower performances on the Processing Speed Index (PSI) compared with other index scores. This pattern of results was quite similar to subjects with reading LD that comprised the standardization sample of the WAIS-3 (Psychological Corporation, 1997). As expected, mean scores on measures of passage comprehension were 12 standard score points below the mean.

Correlations among the index scores of the WAIS-3 demonstrated significant correlations with measures of reading comprehension and composite memory scores (Table 2). Of importance to this study, correlations between measures of reading comprehension, the WMI, and CVLT-2 composite learning score were significant at the 0.01 level. A partial correlation controlling for intelligence continued to identify a significant relationship between working memory and global memory ($p < 0.05$). Regression analysis showed WMI to be the only significant predictor of reading comprehension among demographic and cognitive index scores.

Finally, to further evaluate the impact of verbal memory on reading comprehension, subjects were divided into 3 groups based upon reading ability. The ANOVA was significant ($F(2, 85) = 5.09$, $p < 0.01$). Post hoc comparisons showed subjects with the lowest performances on measures of reading had significantly lower composite memory scores in comparison with subjects with higher reading ability.

DISCUSSION

Statistical trends from recent history suggest that more students with LD's are attending institutions of higher education (Gregg, 2007). These individuals face the same demands of academic programming as their peers, yet they face unique challenges given the nature of their disabilities. Most post-secondary institutions provide supports and accommodations for individuals with LD but there is still much to learn about the efficacy of resources and methods used to support this population.

This study sought to evaluate verbal memory functioning in adults with LD who are attending post-secondary education. Results yielded lower performances on standardized measures of working memory, visual-motor processing speed, auditory learning and memory, and reading comprehension. While past research has consistently shown that working memory impairments exist in individuals with LD, the current study extended findings to global measures of memory and reading comprehension (Swanson & Siegal, 2001). Results suggest that difficulties in working memory and processing speed persist into adulthood for the majority of individuals with LD. While individuals may learn strategies to manage and compensate for weaknesses in learning, it is apparent that patterns of cognitive difficulty persist beyond childhood and adolescence. This likely accounted for the problems college students with LD identified when questioned about the challenges they faced in their academic studies (Heiman, 2003).

The subjects in this study had varying levels of cognitive ability as identified by the large standard deviation of full-scale intellectual functioning (although the overall mean fell within the average range). This result is consistent with the existing literature

for individuals with LD, where significant fluctuations in full-scale intelligence are more common (Wechsler, 1997). These fluctuations are likely attributed to impairments in the major cognitive factors associated with global intelligence including working memory and processing speed. However, results suggested that after controlling for the variable of global intelligence, working memory continued to have a strong correlation with reading comprehension. Thus, working memory capacity underscores an important component of reading ability as has been suggested in studies with children. Fluent reading requires rapid access of stored verbal knowledge. Reduction in working memory capacity appears to slow down this process, which has implications for students in higher education where high demands around reading are required. As anticipated, results were magnified for subjects with poorer reading ability, with weaker readers showing significantly poorer verbal working memory and memory performance. The implication is that these individuals appear to face greater challenges in a classroom context where managing the high demands of reading, in conjunction with learning, are essential.

Working memory is an important higher order cognitive ability included in comprehensive assessments of intellectual functioning. Working memory plays an important role in facilitating the comprehension and mental representation of the immediate environment. It also allows for the retention of information about the immediate past, supports the acquisition of new knowledge, allows one to link ideas together, and to formulate relate, and act on current goals (Geake & Dodson, 2005). Working memory has an important relationship to creative intelligence and studies among gifted individuals correlate working memory with fluid analogical reasoning (Geake & Hansen, 2005). It is not surprising that surveys of adults with LD identify problems with traditional methods of studying which typically entail rote and repetitive learning. The study by Heiman and Precel (2003) strongly suggested adults with LD find oral and written explanations to be helpful for learning. These strategies may help to address the deficits of working memory by activating other neural networks in the brain and facilitating learning by association. Simply emphasizing rote repetition does not appear to be an effective strategy given that working memory performance does not appear to improve over the course of the developmental lifespan. However, optimizing an individual's learning style by building upon cognitive strengths appears to be helpful in supporting adult students with LD.

LIMITATIONS

The weaknesses of this study relate to the generalizability of test findings. Subjects were viewed as a homogeneous group, yet demographic, psychosocial, and personality variables vary considerably in the adult population. In essence, the subjects in this study were likely to face different problems throughout their developmental history and have a wide range of individual resilience and familial support. Second, while results suggest weaknesses in reading comprehension, it is not known how this translates into academic problems. While all subjects were referred because of reported difficulties keeping up with programs of study, the ultimate impact on a subject's school performance would vary. Third, study definitions of LD followed the DSM-IV diagnostic criterion, but this standard is not widely accepted as the best description of a

learning disability. Thus results may not generalize to populations where different definitions of learning disabilities are held.

CONCLUSION

In conclusion, this study investigated a unique and specific outcome of learning disabilities in the adult population. It is apparent that those with LD face not only the challenges related to difficulties with academic functioning (especially reading), but underlying cognitive deficits that may have a more global impact on learning. The current literature indicates that more adults with LD are attending higher education and that they are receiving support for their disabilities. Nonetheless, the best approach to serving and supporting this population remains an area of interest which requires greater understanding and can only be made more clearly through further research with adults with LD.

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Table 1. Descriptive Statistics

	Mean (standard deviation)	Range
Age	27.73 (8.75)	17-51 years
Education	12.11 (1.9)	3-16 years
FSIQ*	93.80 (14.01)	81 – 134
VIQ*	93.49 (13.81)	75 - 133
PIQ*	95.54 (14.46)	78 - 135
WMI*	90.12 (13.14)	71 - 126
PSI*	92.15 (14.30)	74 - 134
WJ-3 Pass. Comp.*	88.72 (8.66)	70-112
CVLT-2 trial 1**	- 0.60 (1.12)	-2.5 – 2.5
CVLT -2 Total***	47.89 (11.30)	15 - 65
Gender Composition	53 Males, 54 Females	

Note. FSIQ = Full Scale Intelligence Quotient; VIQ = Verbal Intelligence Quotient; PIQ = Performance Intelligence Quotient; WMI = Working Memory Index; PSI = Processing Speed Index; WJ-3 = Woocock Johnson Test of Achievement, 3rd Edition, Passage Comprehension; CVLT – 2 = California Verbal Learning Test, 2nd Edition
* denotes standard scores mean = 100, SD = 15;
** z-score means 0.0, SD = 1.0;
***denotes T-score mean = 50, SD = 10.

Table 2. Partial Correlation Coefficients between Intelligence variables, reading comprehension and verbal learning and memory Controlling for Full-Scale Intelligence.

	WMI	PSI	Pass Comp.	CVLT-2 Trial 1
PSI	0.32*			
Pass Comp.	0.29*	-0.02		
CVLT-2 Trial 1	0.26*	-0.24	0.01	
CVLT-2 Total Score	0.28**	0.12	0.32*	0.02

Note. WMI = Working Memory Index; PSI = Processing Speed Index; Pass Comp = WJ-3 Passage Comprehension; CVLT – 2 = California Verbal Learning Test, 2nd Edition
* $p < .05$.
** $p < 0.01$