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Relationship between Verbal Working Memory Deficits and Developmental Dyslexia: The Unusual Mind

Abstract

The focus of the current research was to investigate the relationhip between verbal working memory and developmental dyslexia in Pakistani young students. Verbal working memory is about how the verbal information is stored and prcessed. Twenty dyslexic and non- dyslexic students were selected for the present study. A comparison was drawn between them to assess their verbal working memory capacity and sentence processing ability on the basis of sentences listening and reading tests. The results showed a considerable poor performance of Pakistani dyslexic students as compared to non-dyslexic students in their ability to recall not only words but also sentences and their comprehension in both forms that is, verbal as well as written. The study determined relationship between developmental dyslexia and weak verbal working memory. It was also concluded that it is imperative to help dyslexic students to be trained how to use verbal working memory effectively for the learning efficacy.

Key Words*: Developmental Dyslexia, Pakistani Dyslexic Students, Verbal Working Memory*

Introduction

Dyslexia in the medical texts is termed as 'word blindness' (Morgan, 1896). The findings of the biological researches share the essential mechanisms of dyslexia and the behavior of the brain.

Substantial research (e.g., Grigorenko, 2001) is present that regard genetics as one of the determinants of dyslexia followed by the importance of environmental factors as well as genotype-environment connections. Similarly, research conducted by Snowling & Hayiou-Thomas (2006) share that parents not only provide the home environment but also transfer the genes that effect the language and literacy abilities of the child.

Dyslexia is manipulated by various factors such as cognitive, biological and environmental. Functions of the brain comprises of the malfunctioning of the brain and the problems in learning due to the brain structure. Next, cognitive factors comprises of how one's brain is processing the various information received and the different problems faced while processing information. Lastly, the environmental factors that comprise the society, like the family and the most important the parents (Khalid & Anjum, 2019).

According to Youman & Mather (2013) besides reading and linguistic difficulties found in dyslexic students they can also face memory problems and an incapability to sequence features while executing simple mathematics. The intensity of dyslexia just like most of the learning difficulties falls between the diagnosis spectrum that lies between the range of very low to very high (Vogel, 2003). Another problem that dyslexics may suffer from is the inefficiency in their short-term and working memory in relation to people of their age (Elftorp, 2015).

In Pakistan, children having dyslexia are in a miserable position since they face feelings of guilt, embarrassment and shame. It is hard to find such children and mostly data collectors usually miss them as their focus is usually on severe cases. There are 10-18% children in Pakistan who are dyslexic (Habib & Naz, 2015). As a result of poor automatic information-handling procedures, dyslexics face difficulties in cognition, have distorted memory and an inability in carrying out basic learning activities. This results in impaired working memory (Spark, Fawcett). Although, the reason of being dyslexic maybe neurobiological yet, they are considered as 'good for nothing' in the society.

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There is no research found in the Pakistani context that discusses about the association between developmental dyslexia and verbal WM. The purpose of this paper is to find the link between the two variables. Hence, a comparison was made between dyslexic and non-dyslexic students to gauge the working memory capacity and the ability of sentence processing. Sentence listening and reading tests were used for this purpose.

Literature Review

Children with learning disabilities(LD) are usually described as 'slow', 'problematic', 'clowns', 'backbenchers', etc. In Pakistan, 10% to 18 % students in private schools have various learning disabilities and attention towards such students is negligible (Pakistan Today, 2011). On the other hand, in the United States, in the educational institutions learning disabilities are an important domain and are usually identified at an early stage. All the necessary support is provided to the students having any kind of a learning disability (Youman & Mather, 2013). According to Baddley (1992) an individual with learning disability faces problems in attaining and absorbing information as well as achieving academic abilities as compared to his peers when most importantly these disabilities are not related to any sort of a physical handicap. There are numerous disorders under the umbrella of learning disabilities like varying levels of concentration, low attention spans, not organized in their daily chores, lack of comprehending abstract concepts in mathematics and most importantly difficulties related to language which comprises of speaking, reading and writing (van Genuchten, Cheng, Leseman, & Messer, 2015). Learning disabilities not only have an adverse impact on the academic achievements of such individuals but also create difficulties for them socially as well as emotionally. They can have problems in making friends and may have social adjustment issues with people around them as well as their concerned families.

Developmental dyslexia is usually considered as dyslexia. It is an inherited deficiency in the neurocognitive domain and causes problems in grasping and absorbing knowledge (Fischbach, Könen, Rietz, & Hasselhorn, 2014). Research by Schumacher, Hoffman, Schmal, Schulte-Korne, and Nothen (2007) on genetics depicts the fact that the chromosomes 1, 2, 3, 6, 11, 15, 18 are associated with dyslexia. However, the major site is the 6^{th} chromosome where the genes have been associated possibly with the phonological discrepancies. Hence, dyslexia is linked with genetics. Moreover, the environment also has been reported by Kelly & Phillips (2016) to impact the fetus that may most possibly cause dyslexia in the individual. According to Tummer and Greaney (2010) some of the most common difficulties that dyslexics face are words recognition, correct spellings and pronunciations.

Unfortunately, in Pakistan according to a study conducted in Lahore by Ashraf & Majeed (2011) reveal that no student in any of the public schools has ever been diagnosed of dyslexia. This is due to the fact that the schools lack awareness towards its diagnosis and there are no standardized tools to assess dyslexic pupils in the native language. This results in demotivated students since they are categorized as academically poor. Another study by Irshad (2005) was conducted to evaluate the prevalence of specific learning difficulties among primary grade female students in Pakistan. The results shared a lot of emotional instability amongst such students.

Working memory (WM) is the capability to concurrently retain and handle the information for a short period of time. Hence, the bulk of information that we can hold at a certain time is termed as our working memory capacity. Individuals have various working memory capacities. Different researches (Alloway, 2006 ;Swanson, Cochran, & Ewers,1990) have been conducted to find the connection between the two variables, that is, WM and learning. According to Kane, Conway, Hambrick, and Engle, (2008) WM helps the mind to be focused as well as keeps away the distractors that hinder information processing. In children, working memory is very important while doing various oral and written tasks. Baddley (1990) states that working memory works in collaboration with the short term memory (STM). It helps the mind to manipulate, sort and file up information that is important; as a temporary storage unit. Although both WM and STM work in collaboration in information processing yet, their functions are distinctive. Working memory plays a very important role in the process of learning since it holds on new as well as former data. Hence, WM performs a key part to develop critical thinking as well as reasoning skills amongst individuals. To complete the tasks involving these skills it is important that the cognitive procedures present in the STM work along (Alloway & Gathercole, 2006). Individuals develop a learning disability when there are problems in the process of working memory. Therefore, working memory exhibits an important component towards dyslexia as it briefly holds on information and then transfers it to long term memory (LTM) (Fischbach, Konen, Rietz, & Hasselhorn, 2014).

Language delays are often related to developmental dyslexia. However, according to Baddeley (20036) WM plays a critical role towards language development. Similarly, many studies (e.g., Masoura, 2006) have informed a strong relationship between WM and phonological processing. In the study conducted by Moser, Fridriksson, & Healy (2007) dyslexics face problems while processing sentences due to poor WM capacity. Swanson & Jerman (2007) reveal a strong association between reading skills and WM capacity. There are two types of reading skills; firstly, reading decoding which is initially linked to the visual-spatial STM and secondly is reading comprehension which is linked to the executive WM (Swanson, Howard, & Saez, 2006). According to Palmer (2000) readers must decode

the printed letters (graphemes) into phonemes. The graphemes have to be stored till such time that the recoding occurs. Next, the STM holds on the sequence of phonemes till complete patterns of blended sounds are converted in the form of a word. In the final stage the executive WM becomes active particularly in the stage of blending. To effectively recode and blend words individuals require the ability of phonological processing (National Reading Panel, 2000). In reading comprehension the individuals must have the ability to grasp the words as well as sentences in the consciousness till such time that the reader has relevant information to comprehend an idea (De Beni, Borella, & Carretti, 2007). Thus reading comprehension relies cognitively on the executive WM. Other than sufficient executive WM, sufficient phonological storage is necessary for oral language comprehension since it retains the sequence of the words long enough to decode them according to their respective meanings (Baddley, 1990). According to De Beni & Palladino (2000) dyslexics are unable to discard irrelevant information that affects the skill to take part in the processes that are important towards good comprehension.

Methodology

Objectives

The aim of this present research is to find out the connection between verbal working memor and reading difficulties faced by Pakistani dyslexic students.

The study aimed at the following objectives:

1. Dyslexic students like other normal peers store oral information after listening to the given sentences
2 Dyslexic students like other normal peers store oral information after reading sentences
3. Dyslexic students process the oral information after listening and after reading sentences

Participants

IQ level of the participants was taken as the control variable and students' IQ was determined by assigning them Raven's Standard Progressive Matrices, a standardized nonverbal IQ test. The standardized nonverbal comprised of sixty-four items in which the students were required to identify the missing elements in twenty- five to thirty minutes. Only those students who scored between the average range were selected for the study. In this way 20 dyslexic students studying in grade 3, 4 & 5 from six private schools were selected for the study and 20 normal students from the same class and school were selected.

Research design

A quantitative approach was used in the current research.

Experimental Group (EG) and the Control Group (CG)

The experimental group comprised of students who were dyslexic whereas the control group comprised of the other non-dyslexic students. Participants of the EG and CG have scored between average range on Raven test

Research Tool

Memory span task designed by Leong, Tse, Loh & Lari (2008) was used in English to design a verbal working memory test.

Procedure

The complete test comprising of four tests was administered to both the groups. In both test 1 and 2 group members were supposed to listen to the sentences and tests 3 & 4 they were asked to listen to a set of sentences and to recollect the last words of sentences and respond to the question related to a sentence in the group.

Test 1

Test 1 consisted of 8 groups of sentences. There were 2 sentences in the first group, 3 sentences in the second group, 4 sentences in the third group and 5 sentences in the fourth group.

Test 2

In Test 2 the participants were asked to listen to 5 sentences and repeat them word to word. At the end they were asked to respond in the form of 2 short sentences that were based on 2 comprehension questions.

Tests 3

Test 3 required that the respondents read sentences and recall the last words and at end they were to answer comprehension based questions. Like Test 1 it also comprised of 8 groups. First group consisted of 2 sentences, second group consisted of 3 sentences and third group consisted of 4 sentences and the fourth group consisted of 5 sentences.

Test 4

In Test 4 students were asked to read the given 5sentences and repeat word by word and after repeating the last sentence they were asked to answer 2 questions based on 2 sentences. All students were given tests in the same order. Before each test students were given a trial so that they could understand what they were expected to do. A gap of 7-8 minutes was given between the two tests. Students were given ample time to complete the tests. It took 90 minutes to complete the test.

Marking of the Tests

- One mark was awarded for each correct recall
- Two marks were awarded for each correct answer of the question

Data Analysis

The students' ability to recall both words and sentences helped in assessing the storage capacity of the students whereas comprehension tasks were connected to processing and comprehending sentences. Quantified data was descriptively analyzed. Mean scores of different age group of both the categories of students under study were set side by side using independent sample t-test.

Data Presentation

Table 1:

Demographics of the participants

Class	Age	No. of participants in the Control Group	No. of participants in the Experimental Group
3	8+	5	5
4	9+	7	7
5	10+	8	8

Table 2:

Percentage Mean Scores of the Control Group and the Experimental Group (Tests 1 & 3):

Tests 1 &3	Control Group Mean Score in %	Experimental Group Mean Score in %
1. Recall the last word of each sentence after listening	70%	50%
2. Recall the last word of each sentence after reading	85%	42%
3. Answer a comprehension question after listening to the sentences	50%	16%
4. Answer a comprehension question after reading the sentences	65%	20%

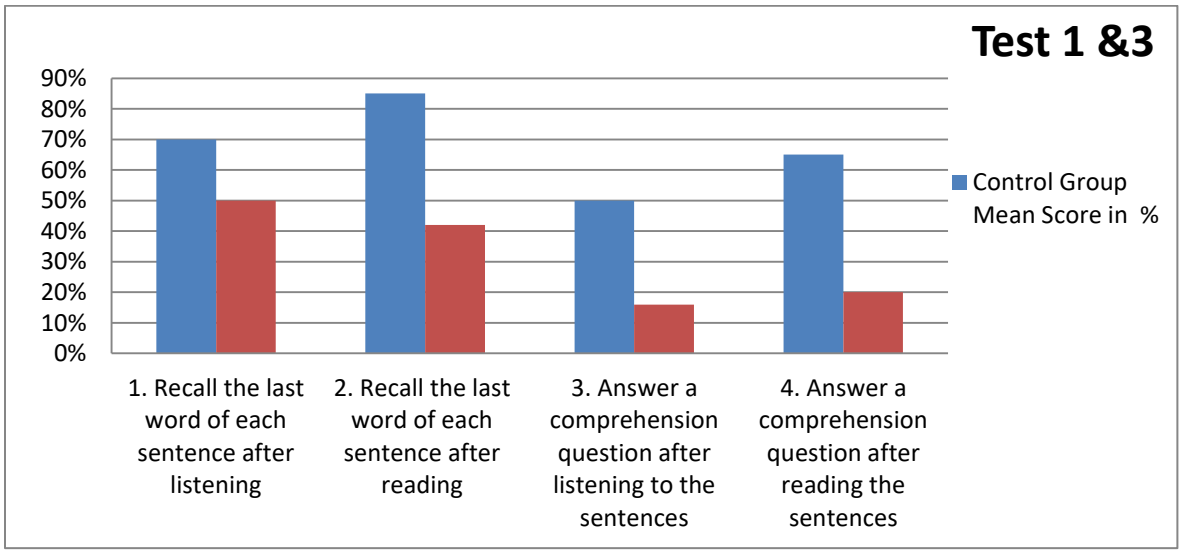

Figure 1. Illustrates the findings of the verbal WM tests based on the recall of words and comprehension of the sentences

Table 3:

Percentage Mean Scores of the Control Group and the Experimental Group (Tests 2 & 4)

Tests 2 & 4	Control Group Mean Score in %	Experimental Group Mean Score in %
1. Repeat the sentence after listening	40%	24%

2. Repeat the sentence after reading	50%	18%
3. Answer comprehension questions after listening	65%	30%
4. Answer comprehension questions after reading	75%	50%

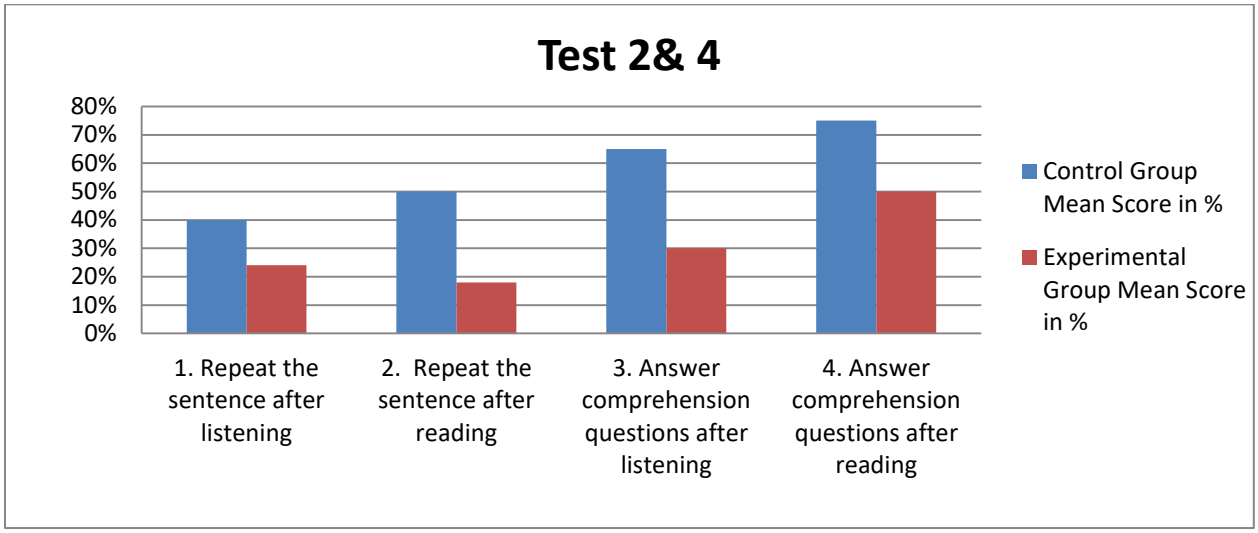

Figure 2. depicts the results of the verbal WM tests based on the recall of sentence and its comprehension.

Table 4:
T- value for the whole test.

S.No	Tests	N	t	Df	p-value
1	Recalling the last word after listening	20	-16.7	38	0.00
2	Recalling the last word after reading	20	-19.7	38	0.00
3	Answer the questions after listening	20	-13.5	38	0.00
4	Answer the questions after reading	20	-24.4	38	0.00
5	Listen and repeat the whole sentence	20	-4.2	38	0.00
6	Read and repeat the whole sentence	20	-11.9	38	0.00
7	Answer the questions after listening	20	-4.7	38	0.00
8	Answer the questions after reading	20	-3.5	38	0.01

Results

Test 1 & 3 was based on the students' ability to recall the last word after listening to and reading the given sentences and to answer the comprehension question. The results of independent t-test depicted that the control and the experimental group both performed well on word recall as compared to answering the required questions. It was also found that EG respondents' performance was worse than the CG students. Furthermore, the independent t-test findings showed that EG respondents performed considerably poorer than CG respondents in their ability to sentence listening and repetition; sentence reading and repetition; answering comprehension questions after listening.

Discussion

Simmons, Taylor, and Oslund (2013) proved that knowledge of letters is fundamental to develop the ability to read and spell and is the base of literacy related skills (p.473). Velluntino (2008) stated that identification of letters should be evaluated at the early stage, that is; at kindergarten and prediction of intervention related to reading achievement specifically is considered at the end of grade second (p.472). Students should be able to identify the letters as well as to read and comprehend sentences. Aldof, Catts, and Lee (2010) stated that identification of letters or identification of an alphabet leads to the decoding of words and then the next step is to read a printed word by forming a word from the letters in order to comprehend the passages. Poor readers are unable to decode a word or letter and so are unable to read or identify a printed letter. They are unable to identify words and might later on

prove to be good at comprehension while the students who are good at recognizing words at an early age may become weak in comprehending sentences later on.

The findings of the current research showed that the performance of the dyslexic students was considerably low in relation to non-dyslexic students in the four tests of the verbal working memory. Hence, Pakistani children with dyslexia were significantly weaker in their ability to store verbal information when they were asked to listen to or read out sentences. This was evident in their poor presentation to recall the words and sentences. The tests that were based on recalling the words, the students concentrated on the last word of each sentence. All the words were piled in the WM until they were able to recall the last words verbally of all the sentences that they had heard or read. With the rise in the amount of sentences there is a need to expand the WM capacity since there will also be an increase in the final words that need to be stored and remembered. Hence, more cognitive processes are is required to recall a sentence as compared to word recalls. In recalling the sentence, the students were to recall each and every word in every sentence, and if the students were unable to comprehend the sentence, it became challenging for them to remember the sentence. On the contrary, there was no comparison between the dyslexic students and non-dyslexic students when it came to the processing information that was verbal after they had listened to or read sentences. This was evident when they showed low performance while comprehending different questions. At the time when students of dyslexia listened and read the given collection of sentences they processed every sentence in order to comprehend the meaning of it. Next, they had to recall the information in it. This process was followed to help them get ready to answer the comprehension based question(s) that were centered on remembering all of the final words as well as sentences. Thus, the ability to comprehend the meaning of every sentence in a group as well as to have inadequate WM capacity to store the required information present in the sentences resulted in performing lower as compared to responding to questions that were based on comprehension\understanding. In addition to this, children with dyslexia as compared to other children not only performed poorly in their assessments while reading sentences but also when listening to sentences. Hence, these findings depict the low levels of performance of children with dyslexia with regards to recalling words, sentences as well as responding to questions based on comprehension that were not only linked to language modality but was related to the underlying poor verbal WM that involved the capacity to store information as well as the ability to process language. Lack of the working memory is one of the reasons for the dyslexic students to become proficient in phonological awareness. Although phonological awareness is an important factor to deal with the students have dyslexia but working memory is also an important factor for the identification of the students having dyslexia. According to Squires, Gillam, and Reutzel (2013), WM is an impulsive system where sensory language information is stored as well as temporarily operates functionally. Children who have weak WM are not able to execute more than one task at the same time. In 2009 the study conducted by Wiseheart, Altman, Park, and Lombardino revealed that dyslexic students had a particular deficiency in the phonological element of WM that supported the phonological deficit of dyslexia. This disability deficiency disallows the students with dyslexia to make a meaning of the text. Carretti, Re, and Arfe in (2013) stated that WM excludes the text that does not have any meaning that is irrelevant and retains the text that gives some information. WM is more complex for the dyslexic students as they are unable to identify a word, decode it and make a meaning from the text. Therefore, it is quite difficult for the children with dyslexia to decode word and link it with the information they already know. Students with dyslexia consume a longer duration while handling required information because it is hard for them to connect letters with their sounds (Layes, Lalonde, Mecheri, and Rebai, 2015). It requires perfect stimuli for the students having dyslexia to save the data in both STM as well as in LTM.

If a student is unable to save information in STM for a long duration it will be impossible for him/her to shift that information in long term memory and it would be an immediate challenge for the teachers to deal with these types of students. It directly links to reading textual material. Thus, it is important that the person who reads must be able to save its information in STM to retrieve the information and save it in LTM. It is vital that teachers should be able to identify the students have problem in retaining the information for a longer time and to understand the reason why such students are unable to understand the text and decode it accordingly.

Limitations of the study

The current research has a quantitative approach. It was difficult to find dyslexic students since such students are often undiagnosed in Pakistan. Therefore the sample size selected was small and the findings were limited to six schools only.

Conclusion

The study concludes that dyslexics perform considerably poorer than non-dyslexics towards sentence listening and repetition; sentence reading and repetition; answering comprehension questions after listening. Overall, the present research gave an in-depth understanding of the relationship between developmental dyslexia and weak verbal working memory. Therefore, there is a dire need to help dyslexic children to be educated on how to use verbal working memory successfully for their learning efficacy.

References

Adlof, S. M., Catts, H. W., & Lee, J. (2010). Kindergarten Predictors of Second Versus Eighth Grade Reading Comprehension Impairments. *Journal of Learning Disabilities, 43*(4), 332-345. Retrieved January 31, 2016, fromx http://journaloflearningdisabilities.sagepub.com

Alloway, T. P. (2006). How does working memory work in the classroom? *Educational Research and Reviews, 1*(4), 134-139.

Alloway, T. P., & Alloway, R. G. (2010). Investigating the predictive roles of working memory and IQ in academic achievement. Journal of Experimental Child Psychology, 106, 20-29.

Ashraf, M., & Majeed, S. (2011). Prevalence of dyslexia in secondary school students in Lahore. *Pakistan Journal of Psychological Research, 26*(1), 73-85.

Baddeley, A. D. (2003). Working memory and language: An overview. Journal of Communication Disorders, 36, 189–208.

Baddeley, A. D. (1990). The development of the concept of working memory: Implications and contributions of neuropsychology. In G. Vallar & J. Shallice (Eds.), Neuropsychological impairments of short-term memory (pp. 54–73). New York: Cambridge University Press

Baddeley, A. D. (2006). Working memory: An overview. In S. J. Pickering (Ed.), Working memory and education (pp. 1–31). Burlington, MA: Academic Press.

Carretti, B., Re, A. M., & Arfe, B. (2013). Reading Comprehension and Expressive Writing: A Comparison Between Good and Poor Comprehenders. *Journal of Learning Disabilities, 46*(1), 87-96. Retrieved January 31, 2016, from http://journaloflearningdisabilities.sagepub.com

De Beni, R., & Palladino, P. (2000). Intrusion errors in working memory tasks: Are they related to reading comprehension ability. Learning and Individual Differences, 12, 131–145

De Beni, R., Borella, E., & Carretti, B. (2007). Reading comprehension in aging: The role of working memory and metacomprehension. Aging, Neuropsychology, and Cognition, 14, 189–212.

Fischbach, A., Konen, T., Rietz, C. S, & Hasselhorn, M. (2014). What is not working in working memory of children with literacy disorders? Evidence from a three-year-longitudinal study. Reading Writing, 27, 267-286.

Gathercole, S. E., & Alloway, T. P. (2004). Working memory and classroom learning. Dyslexia Review, 15, 4–9.

Grigorenko, E. L. (2001). Developmental dyslexia: An update on genes, brains, and environments. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 42*(1) 91–125.

Irshad, E, E. (2005). *Specific learning difficulties: Diagnosis and implication for social psychological functioning* (Unpublished doctoral dissertation).University of Peshawar, Peshawar.

Kane, M. J., Conway, A. R. A., Hambrick, D. Z., & Engle, R. W. (2008).Variation in working memory capacity as variation in executive attention and control. In A. R. A. Conway, C. Jarrold, M. J. Kane, A. Miyake & J. N. Towse (Eds.), Variation in working memory. New York: Oxford University Press; pp. 22-48.

Kelly, K., & Phillips, S. (2016).*The contribution of theories of causation to the development of a multi-sensory teaching programme. In Teaching literacy to learners with dyslexia: A multi-sensory approach (2nd ed.).* Thousand Oaks, CA: SAGE. Retrieved from https://in.sagepub.com/en-in/sas/teaching-literacy-to-learners -with-dyslexia/book245740

Khalid , M. & Anjum, G. (2019). Use of remedial teaching approaches for dyslexic students: Experiences of remedial teachers working in urban Pakistan 6(1), 1-18*Cogent Psychology.*

Layes, S., Lalonde, R., Mecheri, S., & Rebai, M. (2015). Phonological and Cognitive Reading Related Skills as Predictors of Word Reading and Reading Comprehension among Arabic Dyslexic Children. *Psychology, 6*, 20-38. http://dx.doi.org/10.4236/psych.2015.61003

Leong, C., Tse, S., Loh, K. & Hau, K. (2008). Text comprehension in Chinese children: Relative contribution of verbal working memory, pseudoword reading, rapid automatized naming, and onset-rime phonological segmentation. Journal of Educational Psychology, 100 (1), 135-149.

Masoura, E. V. (2006). Establishing the link between working memory function and learning disabilities. Learning Disabilities: A Contemporary Journal, 4, 29–41.

Moser, D. D., Fridriksson, J., & Healy, E. W. (2007). Sentence comprehension and general working memory. Clinical Linguistics & Phonetics, 21, 147–156.

National Reading Panel. (2000). Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its applications for reading instruction.

Washington, DC: National Institute of Child Health and Human Development (NICHD).
Palmer, S. (2000). Phonological recoding deficit in working memory of dyslexic teenagers. Journal of Research in Reading, 23, 28–40.
Pakistan Today, (LAST UPDATED JULY 23, 2011). '10 to 18 percent of children suffer from learning disabilities.'
Raven, J.C. (2008). Standard Progressive Matrices (Kit). London: Pearson Assessment
Schumacher, J., Hoffman, P., Schmal, C., Schulte-Korne, G., & Nothen, M. M. (2007). Genetics of dyslexia: The evolving landscape. *Journal of Medical Genetics, 44*, 289– 297. doi:10.1136/jmg.2006.046516
Simmons, D. C., Taylor, A. B., Oslund, E. L., Simmons, L. E., Coyne, M. D., Little, M. E., Kim, M. (2013). Predictors of at-risk kindergarteners' later reading difficulty: Examining learner-by-intervention interactions. *Springer Science Plus Business Media*, *27*, 451-479.
Squires, K. E., Gillam, S. L., & Reutzel, D. R. (2013). Characteristics of Children Who Struggle With Reading: Teachers and Speech-Language Pathologists Collaborate to Support Young Learners. *Early Childhood Education Journal, 41*, 401-411.
Smith-Spark, J. H., Fisk, J. E., Fawcett, A. J., Nicolson, R. I. (2003). Investigating the central executive in adult dyslexics: evidence from phonological and visuospatial working memory performance. *European Journal of Cognitive Psychology. 15*, 567–587. doi:10.1080/09541440340000024.
Snowling, M. & Hayiou-Thomas, M. E. (2006). The dyslexia spectrum: continuities between reading, speech, and language impairments. *Topics in Language Disorders*, *26*(2) 110–126.
Swanson, H. L., Cochran, K. F., & Ewers, C. A. (1990). Can learning disabilities be determined from working memory performance? *Journal of Learning Disabilities*, *23*:59-67.
Swanson, H. L., Howard, C. B., & Saez, L. (2006). Do different components of working memory underlie different subgroups of reading disabilities? Journal of Learning Disabilities, 39, 252–269.
Swanson, H. L., & Jerman, O. (2007). The influence of working memory on reading growth in subgroups of children with disabilities. Journal of Experimental Child Psychology, 96, 249–283
Vellutino FR, Scanlon DM, Zhang H, Schatschneider C. Using response to kindergarten and first grade intervention to identify children at-risk for long-term reading difficulties. Reading & Writing: An Interdisciplinary Journal. 2008;21:437–480.
Wiseheart, R., Altmann, L. J., Park, H., & Lombardino, L. J. (2009). Sentence comprehension in young adults with developmental dyslexia. *The International Dyslexia Association, 59*, 1511.