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EXAMINING THE RELATIONSHIPS BETWEEN PERCEPTUAL LOAD PATTERNS, SELECTIVE ATTENTION AND VISUOSPATIAL WORKING MEMORY OF TWICE EXCEPTIONAL PUPILS WITH DYSCALCULIA OF PRIMARY STAGE

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Abstract:
The research aims to examine the relationships between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia of primary stage. The sample size consisted of 20 twice exceptional pupils with dyscalculia from sixth primary grade. The instruments were used for date collection: ordinary matrices test, prepared by Raven (1938); reading comprehension test, prepared by researcher; basic mathematical operations test, prepared by researcher; Bender gestalt test of motor visual disorder, prepared by Loretta Bendar (1938); Arabization by Fahmi, Ghoneim, Abu Al-Azayem Hospitalization (1990); quick survey form prepared by researcher; Wechsler 's Test of Children's Intelligence - Revised (1974), Arabization by Ismael and Malika (1999) ; selective attention task, prepared by researcher ;Computerized Verbal and Visual perceptual load pattern tasks (high-medium-low) prepared by researcher and Computerized Visuospatial working memory tasks (Pattern memory-Visual spatial sequencing) prepared by researcher. The date collected were analyzed by using the following statistical methods: frequency counts, percentages, Step-wise multiple regression analysis statistics, Z scores. The research concluded that perceptual

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load patterns, selective attention were very good predictors of visuospatial working memory of twice exceptional pupils with dyscalculia of primary stage.

Keywords: perceptual load patterns, selective attention, visuospatial working memory, twice exceptional pupils, dyscalculia

1. Introduction

The term of talented pupils with mathematical learning disabilities (dyscalculia) refers to "*a group of twice exceptional individuals who have above-average intelligence, and their actual achievement in math less than one grade or more of their expected achievement."* And they have deficiencies in internal cognitive processes and basic learning skills which are associated with dyscalculia, auditory comprehension, reading comprehension, written expression, basic reading skills, basic mathematical operations. This concept does not include: achievement retardation, achievement backwardness, learning problems, slow learning, under achievement, visual, auditory, kinetic disorders, emotional disorders, or any environmental deficiencies, cultural or economic problems (Lovett & Sparks, 2013; Reis, Baum, & Burke, 2014; Beckmann & Minnaert, 2018) They can be defined operationally as: "*those pupils who are selected by using the tools and criteria to identify talented pupils with learning disabilities, namely: high IQ (120 and greater), external discrepancy, exclusion, internal discrepancy, as described in the participants' description.*"

It should also be noted that dyscalculia may be due to the limited attention span of twice exceptional pupils with learning disabilities, that they have low perceptual load patterns, take longer to focus on the targeted stimuli and irrelevant neglect, and that their attention span is small, where research has linked perceptual load patterns and performance to selective attention tasks (Wei, Kang, & Zhou, 2013; Neokleous, Shimi, & Avraamides, 2016; Xue, Huang, Wang, Hu, Chai, Li ,& Chen, 2017).

Working memory deficits are likely to be among the contributing causes of some learning disabilities in primary school. Working memory is an active dynamic system that works by focusing on both the storage and processing requirements of the learning situation (Kiyonaga & Egner, 2013, Lewandowski & Lovett, 2014; Jiang, 2017). Swanson, Kehler & Jerman (2010) refer to there are working memory deficit for those with learning disabilities and this functional memory deficits is related to dyscalculia (mathematics learning disabilities) such as: acquiring and understanding concepts and symbols, inadequate information processing, and these disabilities are evident in classification, phonological awareness, and understanding of verbal and numerical issues .So twice exceptional pupils with dyscalculia may have lake in these aspects or in other skills (Geary, Hoard, Byrd-Craven, Nugent & Numtee, 2012, Peng, Sun, Li, & Tao, 2012).

Visuospatial working memory is a set of cognitive processes that temporarily store and process visual spatial information, such as images and forms fixed and animated drawing (Weijer-Bergsma, Kroesbergen, & Luit, 2015). It is measured in this research by

the degree that the pupils obtain on the prepared tasks of visual-spatial working memory: (pattern memory - visual spatial sequencing).

It is therefore likely that, there is a close relationship between working memory, talent, learning disabilities and dyscalculia, and that the best performance of working memory can predict better performance in other academic fields.

It is worth noting that, Lavie (2001) proposed the Hybrid Model or Perceptual Load Theory, which assumed that the process of attention had a specific capacity, but not all stimulus included the processing because the nontarget stimulus still occupy space as long as there is capacity available .

This theory has assumed several patterns of perceptual load;

- high load: in which the number of elements acquires all available capacity, and sometimes exceeds the available capacity,
- medium load: in which elements capture less than the attention required by the high pattern, and
- low load: in which the elements possess a small capacity of attention, and the remaining capacity to capture elements that do not need any kind of focus (Murphy, 2013; Murphy, & Greene, 2017; Gorbunova & Falikman, 2017).

2. Statement of the problem

Some literatures (Arain et al., 2013, Alicia, Pilar, Mateu, & Frederick, 2016) indicate that working memory is a critical component of the information processing model and has a vital impact on cognition, decision-making, problem solving, and the derivation and creation of new information. In addition, low perceptual load patterns, and inability to recognize non-matching stimuli negatively affects different academic areas, including mathematics.

Moreover, investigating the relationships between working memory, perceptual load patterns, and selective attention may provide a comprehensive and accurate understanding of the stages and strategies of a particular behavior or function or even the causes that may lead to a particular disorder. Therefore, we need cognitive representations of these variables and the detection of mechanisms. So, a comprehensive and accurate understanding of these variables requires that they be addressed from the perspective of cognitive psychology so that we can comprehensively examine the reasons for mathematics learning disabilities of the twice exceptional pupils.

From the observations of studies and researches on perceptual load patterns found that some of them dealt with: auditory perceptual load patterns (Murphy, Spence, & Dalton, 2017), as well as their relation to visual recognition (Gorbunova & Falikman, 2017), including the patterns of perceptual loading and processing (Jerger, Damian, Mills, Bartlett, Tyous-Murray, & Abdia, 2013) and mental capacity (Fitousi & Wenger, 2011). The above studies show that scarcity of studies which investigate the relationships

between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia.

However, the relationships between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia of primary stage deserve empirical investigations; hence this research.

2.1 Aim of the research

The aim of this research was to investigate the relationship between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia of primary stage.

The specific objectives are to:

1) determine the relationship between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia.
2) determine the relative contribution of perceptual load patterns and selective attention to visuospatial working memory of twice exceptional pupils with dyscalculia.

2.2 Hypotheses

The following research hypotheses were raised to guide the study:

1) There is no significant relationship between each perceptual load patterns and visuospatial working memory of twice exceptional pupils with dyscalculia.
2) There is no significant relationship between each perceptual load patterns and selective attention of twice exceptional pupils with dyscalculia.
3) There is no significant relative contribution of perceptual load patterns and selective attention to visuospatial working memory of twice exceptional pupils with dyscalculia.

3. Method

3.1 Model of research

The descriptive approach (a relational survey) was used to detect the relationship between variables and to determine the extent and direction of this relationship. Specifically, in this research to discover the relationship between selective attention, perceptual loading patterns and visuospatial working memory of twice exceptional pupils with dyscalculia.

3.2 Participants

The sample of research split into:

A. Verification of psychometric properties sample. The sample of verification of the psychometric characteristics of the research measures, readability, the clarity of the instructions, time and preparation for its final form. A total of 200 sixth grade

pupils of primary stage (97 boys and 103 girls, mean age = 11 years, SD = 0.11) participated in this research.

B. The main sample. This is the basic sample for which the study measures were applied, and through which a set of conclusions and recommendations were obtained. It consists of 20 twice exceptional pupils with dyscalculia in the sixth grade (11 boys and 9 girls, mean age = 11.8 years, SD = 0.12), that were selected from a large sample (396 = 200 boys and 196 girls) according to the criteria of learning disabilities (IQ above average- external discrepancy- internal discrepancy- exclusion), as follows:
    a. The standard matrices test was used to select high IQs pupils and exclude ordinary and low IQs. The sample size was 119 (50 boys / 69 girls) those who got 95 percentile scores or more, Thus the first criteria have been achieved.
    b. Apply the basic mathematical operations test, prepared by the researcher (2019) to estimate the external discrepancy criteria by selecting pupils with a discrepancy between intelligence and basic mathematical operations computation of one or more Z Scores for intelligence by using the Ericsson standard score equation, External, one or greater between intelligence and mathematical operations in favor of Z Score intelligence; to reach the sample size after applying this test to 43 (20 boys / 23 girls).
    c. To exclude those who suffer from hearing impairment, vision, physical disability, cultural deprivation, extreme poverty, family problems or mental disorders, they are based on interviews with the psychologist, social worker and school counselor, examine school pupils' files and history of health status. Apply rapid survey questionnaire to exclude family, economic, physical, health and educational problems and the factors related to cultural deprivation, prepared by researcher.

In the light of this survey, three students were excluded because of the death of their parents, the second due to poor vision, and the third because of their frequent absence from school. The sample size reached 40 pupils (20 boys / 23 girls).

Then, implementation Bender gestalt test of motor visual disorder (quantitative form: 1, 3, 4, 5, 7, 9 cards); for the exclusion of emotional disorders, edited by Loretta Bandar (1938). In the light of this, two pupils were deprived of less than 0.5 ± 14 degrees in the quantitative form of the test, after applying the exclusion criteria; the sample size reached 38 pupils (18 boys / 20 girls).

4) Estimation of the internal discrepancy. The internal discrepancy was estimated in two ways, one for estimating the discrepancy between the academic subjects (reading and arithmetic) and the second for estimating the discrepancy between verbal intelligence (VIQ) and practical intelligence (PIQ) by Wechsler Intelligence Scale for Children (WISC, 1974).

5) Method of discrepancy between academic subjects with a different cognitive structure (Suliman, 2010). And the researcher believes that this method may have some deficiencies due to the lack of identification and specification the nature of skills and cognitive processes on which the idea of the internal discrepancy between reading and mathematics is based. On the one hand, the researcher suggests establishing internal discrepancy on the basic mathematical operations: Addition- subtraction- multiplication - division, and the reading comprehension and its sub-components: reading comprehension, direct/literal comprehension, interpretive comprehension, critical comprehension, affective comprehension and creative comprehension. And after the conversion of the raw scores to standard scores, this method was applied to calculate the internal discrepancy , and retention of pupils whose have discrepancy between reading comprehension and basic mathematical operations is estimated at a one Z Score or greater; to reach the size of the sample to (23) pupils (11 boys / 12 girls) by 6.23% of the total sample size of (369) pupils.
6) Method of discrepancy between (VIQ) and (PIQ). By Using Wechsler 's Test of Children's Intelligence - Revised (1974) to select pupils who have internal discrepancy between (VIQ) and (PIQ). if they have a gap between (VIQ) and (PIQ) By 10 or more weighted scores (mean = 100, SD = 3) in favor of (PIQ). Three pupils were excluded from this method because The discrepancy in favor of (VIQ) not (PIQ) to reach the size of the sample to (20) twice exceptional pupils with dyscalculia (who have mathematics learning disabilities) (11 boys / 9 girls) by 5.4% of the total sample size of (369) Pupils. See table (1) the descriptive statistical indicators of main research sample.

Table 1: Statistical descriptive indicators of mentally talented pupils with dyscalculia

Measure	M.	SD.	Variance	Skewness		Kurtosis	
				Std. Error	Statistic	Std. Error	Statistic
Reading Comprehension	25.7	5.8	33.905	-3.88-	.512	16.332	**.992**
Basic Mathematical Operations	23.2	11.3	128.092	.672	.512	-.732-	**.992**
Practical Intelligence (PIQ)	159.7	1.8	120.116	-.889-	.512	.230	**.992**
Verbal Intelligence (VIQ)	72.7	1.12	38.197	-.505-	.512	.023	**.992**
Age	11.8	0.12	.016	-.722-	.512	-.528-	**.992**

3.3 Data collection tools

These tools were used for date collection:

- The ordinary matrices test, prepared by Raven (1938),
- Arabization by Abdel Raouf (1999), and
- verification of psychometric properties by researcher.
- Reading comprehension test, prepared by researcher .The reading comprehension test consists of five levels, the first level: measures the literal understanding, and consists of (10) items, the second level: measures the deductive understanding,

consists of (5) items, while the third level measures: critical understanding, consists of (5) items, the fourth level measures: gastronomic understanding, consists of (5) items, and finally the fifth level, and measures: creative understanding, consists of (5) items.

- basic mathematical operations test, prepared by researcher. It consists of four sub-tests comprising four operations, addition, subtraction, multiplication, and division. and each operation consists of (24) items.
- Bender gestalt test of motor visual disorder, prepared by Loretta Bendar (1938), Arabization by Fahmi, Ghoneim, Abu Al-Azayem Hospitalization (1990).
- Quick survey form; to exclude those who suffer from hearing impairment, vision, physical disability, cultural deprivation, extreme poverty, family problems or mental disorders, prepared by Researcher. It includes personal data about the pupil, age, description, education al level of father and mother, place of residence, number of family members and monthly household income and consists of (27) items.
- Silent Reading Test, by Sulaiman (2008), verification of psychometric properties by researcher, as criteria to assess criterion related validity.
- Quick survey form for the exclusion of economic, family, health and educational experts, prepared by Sulaiman and Abu Rasin (2008), as criteria to assess criterion related validity.
- Wechsler 's Test of Children's Intelligence - Revised (1974), Arabization by Ismael and Malika (1999).
- Flanker's task of attention, prepared by Eriksen and Eriksen (1974), as criteria to assess criterion related validity.
- School records for pupils.
- Students' grades in the mid-year exam (2018-2019) for Math and Arabic Language, Ministry of Education, Giza Governorate.
- selective attention task, prepared by researcher. It is a set of symbols and shapes, and is required to focus heavily, and write off the forms that will be asked to remove the pupil among the stimuli available as quickly and accurately as possible. Note that this task progresses in difficulty as it starts with the first level, which is the least easy, and ends with the fourth most difficult level.

Example: Delete the following symbols + * from the set of symbols in front of you.

*= + - & @ # **

% + & * + $ *

- Computerized Verbal and Visual perceptual load pattern tasks (high-medium-low) prepared by researcher.
- Computerized visuospatial working memory tasks (Pattern memory- Visual spatial sequencing), prepared by researcher.

Pattern memory: it refers to the ability of the student to call the pattern, which is one of the indicators of spatial visual memory, and is measured by the degree to which

the student in the performance on the task of remembering the pattern, prepared by researcher.

It displays a set of visual matrices for several seconds and then disappears, focusing well in the colored squares inside the matrix in terms of direction, and required to redraw the pattern as seen in full in the blank matrix in the answer sheet in front of you.

Visual spatial sequencing it is the ability of pupils to understand the visual sequence of a set of shapes within a visual matrix, measured by the degree to which a student receives performance on a spatial optical sequence task.

It displays a set of visual arrays for a few seconds and then disappears, focusing well on the stimuli inside the matrix in terms of shape, size, and direction. The matrix is redrawn as seen in the blank matrix in the answer sheet.

The overview of reliability for measures used in the research. In view of the second table, the tools have high stability coefficients, and the validity of the tools used has also been verified using criterion related validity, age differentiation, and discriminatory and the tools have a statistically significant validity coefficients. (see Table 2)

Table 2: Overview of reliability for measures used in the research

Measures	No of items	Split-half reliability		Test re-test reliability	Gutttman reliability	Cronbach's Alpha reliability
		Before correcting the length	After correcting the length			
The ordinary matrices	60	.91	.95	.98	.95	.92
Reading comprehension	30	.85	.88	.88	.69	.85
Basic mathematical operations	96	.71	.88	.79	.79	.90
Bender gestalt test of motor visual disorder	6	.92	.96	.86	.95	.75
Quick survey form	27	.85	.92	.92	.92	.74
selective attention task	4	.58	.74	.88	.73	.71
Verbal perceptual load pattern tasks	18	.71	.83	.64	.83	.70
Visual perceptual load pattern tasks	20	.91	.95	.77	.95	.74
Visuospatial working memory tasks	16	.84	.90	.77	.91	.77
Pattern memory	8	.91	.95	.82	.96	.71
Visual spatial sequencing	8	.58	.77	84	.79	.75

3.4 Data analysis

SPSS v20 was used to analyze the research data by using the following statistical methods: frequency counts, percentages, Stepwise multiple regression analysis statistics to Examine the relationships between perceptual load patterns, selective attention and visuospatial working memory of twice exceptional pupils with dyscalculia of primary stage and determine the proportion of prediction and contribution and Z Scores were used to assess external and internal discrepancy by Ericson equation.

4. Results and Findings

The first hypothesis: there is no significant relationship between each perceptual load patterns and visuospatial working memory of twice exceptional pupils with dyscalculia. The result of the significant relationship between verbal perceptual load pattern and visuospatial working memory of twice exceptional pupils with dyscalculia. (see Table 3)

It shown that visuospatial working memory yielded a coefficient regression (R) of 0.72 and a correlation square (R^2) of 0.52.

These values are statistically significant at 0.05 probability level. visuospatial working memory can only explain for 52% of the observed variance in pupils' Verbal perceptual load pattern. Also, there is significant relationship between Visual perceptual load pattern and visuospatial working memory of twice exceptional pupils with dyscalculia. It shown that visuospatial working memory yielded a coefficient regression (R) of .513 and a correlation square (R^2) of .263.

These values are statistically significant at 0.05 probability level. visuospatial working memory can only explain for 26.3% of the observed variance in pupils' visual perceptual load pattern. These imply that is significant relationship between each perceptual load patterns and visuospatial working memory of twice exceptional pupils with dyscalculia.

Table 3: Summary of regression analysis of relationship between perceptual load patterns and visuospatial working memory of mentally talented pupils with dyscalculia

Model	R	R^2	Adjusted R Square	Std. Error of the estimate	F	P
Verbal perceptual load patterns (High)	0.72	0.52	0.49	1.79	19.5	**.000**
Visual perceptual load patterns (Moderate)	.513	.263	.222	2.22	6.42	**.021**

The second hypothesis is: there is no significant relationship between each perceptual load patterns and selective attention of twice exceptional pupils with dyscalculia.

Table 4 shows the result of the significant relationship between verbal perceptual load pattern and selective attention of twice exceptional pupils with dyscalculia. It shown

that selective attention yielded a coefficient regression (R) of 0.64 and a correlation square (R^2) of 0.41.

These values are statistically significant at 0.05 probability level. selective attention can only explain for 41% of the observed variance in pupils' Verbal perceptual load pattern. Also, there is significant relationship between Visual perceptual load pattern and selective attention of twice exceptional pupils with dyscalculia. It shown that selective attention yielded a coefficient regression (R) of .534 and a correlation square (R^2) of .286.

These values are statistically significant at 0.05 probability level. selective attention can only explain for 28.6% of the observed variance in pupils' Visual perceptual load pattern. These imply that is significant relationship between each perceptual load patterns and selective attention of twice exceptional pupils with dyscalculia.

Table 4: Summary of regression analysis of relationship between perceptual load patterns and selective attention of mentally talented Pupils with dyscalculia

Model	R	R^2	Adjusted R Square	Std. Error of the estimate	F	P
Verbal perceptual load patterns	.641	.410	.300	2.31138	3.714	**.034**
Visual perceptual load patterns	.534	.286	.152	2.54433	2.133	**.013**

The third hypothesis is: there is no significant relative contribution of perceptual load patterns and selective attention to visuospatial working memory of twice exceptional pupils with dyscalculia.

The result of relative contribution of perceptual load patterns and selective attention to visuospatial working memory of twice exceptional pupils with dyscalculia. (see Table 5) Field selective attention had t value of 8.963 respectively while their respective beta weight value is 0.904. This revealed that selective attention had significant contribution to visuospatial working memory of twice exceptional pupils with dyscalculia. So, selective attention was a better predictor of visuospatial working memory. Also, Field selective attention and Verbal perceptual load pattern had t values of 8.549 and 3.139 respectively while their respective beta weight values are 0.781 and 0.287. This revealed that selective attention and Verbal perceptual load pattern had significant contribution to visuospatial working memory of twice exceptional pupils with dyscalculia. Accordingly, selective attention was the first predictor of visuospatial working memory and those selective attention and Verbal perceptual load pattern were the second. And this can be illustrated above the following equations:

Visuospatial working memory = 1.141 + (0.904 × selective attention).

Visuospatial working memory = 0.391 + (0.781 + selective attention) + (0.287 + verbal perceptual load pattern).

Table 5: Results of hierarchical regression analysis predicting visuospatial working memory of mentally talented Pupils with dyscalculia

	Unstandardized coefficients		Standardized coefficients		
Step	**B**	**Std. error**	**Beta**	**T**	**Sig**
Model 1					
(Constant)	1.141	.482		2.367	**.029**
selective attention	.824	.092	.904	8.963	**.000**
Model 2					
(Constant)	.391	.462		.846	**.409**
selective attention	.712	.083	.781	8.549	**.000**
Verbal perceptual load pattern(median)	.738	.235	.287	3.139	**.006**

5. Discussion of Findings

The results of current research can be explained in light of the theory of perceptual loading claims that what occurs within the working memory in general and visuospatial memory, especially if it is efficiently reduced by the interference of attention (Lavie, Hirst, Viding, & Fockert, 2004). Koshino & Olid (2015) indicated that the effect of high perceptual load on the efficiency of visuospatial memory is increased.

This can be illustrated in the light of the interrelationships between perceptual load, working memory and selective attention of target stimuli. Attention to identical and unmatched stimuli, as well as neutral stimuli in high and medium perceptual load patterns, these tasks should require a high degree of information processing when compared with identical stimuli which only represents a low perceptual load pattern. This is confirmed by the fact that there are direct and indirect reciprocal effects between perceptual load and, in some cases, Working memory and selective attention (Tan et al., 2015).

It is also possible that the relationship between the variables is due to the fact that perceptual loading patterns are reflected in the performance of the executive functions and visuospatial working memory of the pupils and that they are a decisive factor in the exclusion of unwanted stimuli by providing synchronous elements that can distract attention. It is also depending on the duration and extent of attention and presentation, selective and delayed attention forms, and that these factors do not function independently because they represent different levels of perceptual load patterns, whether these stimuli are presented visually or verbally. Allen, Baddeley and Hitch (2017) noted a relationship between perceptual load, visual working memory, and executive functions.

In the same context, Koshino & Olid (2015) point out that the relationship between perceptual load and visuospatial working memory is influenced by the rule that the more complex the tasks are increased, the greater the visual working capacity, the coding and processing of the target stimuli are influenced.

The relationship between the variables may be attributed to the existence of a common correlation between the processes involved in visuospatial working memory

(pattern memory- visual spatial sequencing) and those involved in perceptual load in terms of: attention, ability to coding, understanding of Featured stimulus, skills and sub-skills of processing.

It can be considered that the growth of visual-spatial memory plays an important role in increasing attention capacity; it is linked to the activities of working memory and frontal lobes of the brain, and a representation of images is an effective way to reduce the overcrowding on memory and allow the activation of information easily content, In the production of other processes, verbal repetition plays a key role in the preservation of primary data or partial results. When solving a calculation, the parties to the process are: retention numbers and intermediate results (Korkman, Lahti-Nuuttila, Laasonen, Kemp, & Holdnack, 2013).

6. Conclusion

The findings of the research showed that pupils can do well academically when their cognitive processes verbal and visual perceptual loading patterns, visuospatial working memory and selective attention use and work together. Based on the above, the research showed that there is significant relationship between each perceptual load patterns and visuospatial working memory of twice exceptional pupils with dyscalculia and also There is significant relationship between each perceptual load patterns and selective attention of twice exceptional pupils with dyscalculia. Selective attention and Verbal perceptual load pattern had significant contribution to visuospatial working memory of twice exceptional pupils with dyscalculia. And finally, selective attention was the first predictor of visuospatial working memory and thus, selective attention and Verbal perceptual load pattern were the second.

6.1 Recommendations

Based on the findings of this research, the following recommendations were suggested: attention to the category of twice exceptional pupils with mathematical learning disabilities (dyscalculia) is very important and addressing the cognitive processes that their development and improvement can remedy these disabilities. The weakness efficiency of working memory, low selective attention, and low perceptual load patterns among those pupils yielded to difficulty of memorizing mathematical symbols and understanding mathematical processes.

Add to that, usage of appropriate strategies is likely to increase mathematical power, mathematical thinking, mathematical representation processes, mathematical communication, mathematical problems solution and ability to recognize non-identical stimulus and this reflects its impact on other academic aspects.

It is also recommended, teachers should develop their teaching methods and use a variety of strategies to suit with the different perceptual load patterns of their pupils , the nature of individual differences of pupils and support their perceptual load patterns

through activities that use their cognitive abilities and work on improving visuospatial working memory and selective attention to achieve academic success.

References

Alicia, L., Andres, P., Servera, M., Gent, F., & Parmentier, F. (2016). The role of age, working memory, and response inhibition in deviance distraction: a cross-sectional study, Developmental psychology, 52(9), 1381-1393.

Allen, R., Baddeley, A., & Hitch, G. (2017). Executive and Perceptual Distraction in Visual Working Memory. J Exp Psychol Hum Percept Perform, 43(9), 1677–1693.

Arain, M., Haque M., Johal, L., Mathur, P., Nel, W., Rais, A., Sandhu, R., & Sharma, S. (2013). Maturation of the adolescent brain. Neuropsychiatr Dis Treat, 9, 449-461.

Beckmann, E., & Minnaert, A. (2018). Non-cognitive Characteristics of Gifted Students with Learning Disabilities: An In-depth Systematic Review. Front Psychol, 20(9),504.

Fitousi, D., & Wenger, M. (2011). Processing Capacity Under Perceptual and Cognitive Load: A Closer Look at Load Theory. Journal of Experimental Psychology: American Psychological Association Human Perception and Performance, 37(3), 781–798.

Geary, D. C., Hoard, M. K., Byrd-Craven, J., Nugent, L., & Numtee, C. (2007). Cognitive mechanism underlying achievement deficits in children with mathematical learning disability. Child Development, 78, 1343–1359.

Gorbunova, E., & Falikman, M. (2017). Visual Search for Letters in the Right vs. Left Visual Hemifields: The Role of Perceptual Load and Set. Basic Research Program. National Research University Higher School of Economics (HSE). Working Paper. 1-27.

Jerger, S., Damian, M., Mills, C., Bartlett, J., A Tye-Murray, N., & Abdia, H. (2013). Effect of Perceptual Load on Semantic Access by Speech in Children. Journal of Speech, Language, and Hearing Research 56, 388–403.

Jiang, P. (2017). Working memory-related brain activity and networks in typically developing children and young adults. Doctoral Program of Brain and Mind. University of Helsinki; Helsinki, Finland.

Kiyonaga, A., & Egner, T. (2013). Working memory as internal attention: toward an integrative account of internal and external selection processes. Psychon. Bull. Rev. 20, 228–42.

Korkman, M., Lahti-Nuuttila, P., Laasonen, M., Kemp, S., & Holdnack, J. (2013). Neurocognitive development in 5- to 16-year-old North American children: a cross-sectional study. Child Neuropsychol.,19(5),516-39.

Koshino, H., & Olid, P. (2015). Interactions Between Modality of Working Memory Load and Perceptual Load in Distractor Processing. The Journal of General Psychology, 142(3), 135-149.

Lavie, N., Hirst, A., de Fockert, J., & Viding, E. (2004). Load Theory of Selective Attention and Cognitive Control. Journal of Experimental Psychology General, 133(3), 339-54.

Lavie, N. (2001). The role of perceptual load in neglect: rejection of ipsilesional distractors is facilitated with higher central load. J Cogn Neurosci, 13(7),867-76.

Lewandowski, L. J., & Lovett, B. J. (2014). Learning disabilities: in Child Psychopathology, eds New York, NY: Guilford Press, 625–669.

Lovett, B. J., & Sparks, R. L. (2013). The identification and performance of gifted students with learning disability diagnoses: a quantitative synthesis. J Learn Disabil, 46(4),304-16.

Murphy, S. (2013). Determinants of Auditory Selective Attention. Submitted for the Degree of Doctor of Philosophy, Royal Holloway, University of London.

Murphy, G., & Greene, C. M. (2017). Load theory behind the wheel; perceptual and cognitive load effects. Canadian Journal of Experimental Psychology, 71(3), 191-202.

Murphy, S., Spence, C., & Dalton, P. (2017). Auditory perceptual load: A review. Hearing Research ,352 ,40-48.

Neokleous, K., S., & Avraamides, M. (2016). Modeling the Effects of Perceptual Load: Saliency, Competitive Interactions, and Top-Down Biases. Frontiers in Psychology, 7(1),1-15.

Peng, P., Sun, C. Y., Li, B. L., & Tao, S. (2012). Phonological storage and executive function deficits in children with mathematics difficulties. Journal of Experimental Child Psychology, 112, 452–466.

Reis, S. M., Baum, S. M., & Burke, E. (2014). An operational definition of twice-exceptional learners: implications and applications. Gifted Child Q. 58, 217–230.

Suliman, E.A. (2010). Diagnosis of Learning Disabilities: Procedures and Tools (in Arabic). Cairo. Dar El Fekr El Araby.

Swanson, H. L., Kehler, P., & Jerman, O. (2010). Working memory, strategy knowledge, and strategy instruction in children with reading disabilities. Journal of Learning Disabilities, 43(1),24-47.

Tan, J., Zhao, Y., Wang, L., Tian, X., Cui, Y., Yang, Q., Pan, W., Zhao, X., & Chen, A. (2015). The Competitive Influences of Perceptual Load and Working Memory Guidance on Selective Attention. PLOS. ONE, 10(6),5-14 .

Wei, P., Kang, G., & Zhou, X. (2013). Attentional selection within and across hemispheres: implications for the perceptual load theory. Exp Brain Res, (225),37–45.

Weijer-Bergsma, E., Kroesbergen, E., & Van Luit, J. (2015). Verbal and visual-spatial working memory and mathematical ability in different domains throughout primary school. Mem Cogn, 43,367–378.

Xue, L., Huang. D, Wang. T, Hu. Q, Chai. X, Li. L., & Chen, Y. (2017). Dynamic modulation of the perceptual load on microsaccades during a selective spatial attention task. Scientific reports,1-13.