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Cognitive style and working memory among adolescents with specific learning disability

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Abstract:

BACKGROUND: In a world where education directly influences the quality of life of an individual, educational handicaps are a grave issue that plagues the lives of those affected. The current study aims to find out whether there is a difference in the cognitive style and working memory capacity among adolescents with specific learning disability (SLD) in comparison to their age-matched equivalent group without SLD. The study also targets to find out if there exists any relationship between cognitive style and working memory.

MATERIALS AND METHODS: A total of sixty participants were selected (thirty adolescents with learning disability and thirty age-matched adolescents without learning disability) from Bangalore district of Karnataka and Thrissur district of Kerala using purposive sampling method. The tools used were the Indian adaptation of Embedded Figures Test by Nigam (1997) and the Wechsler Intelligence Scale for Children-Fourth Edition by Wechsler (2003).

RESULTS: The results showed that there exists a significant difference in cognitive style dimensions of field dependence and independence between adolescents with learning disability ($M = 11.6$, standard deviation [SD] = 6.52) and adolescents without learning disability ($M = 25.2$, SD = 7.33) as well as in the working memory capacity between adolescents with learning disability ($M = 66.7$, SD = 19.26) and adolescents without learning disability ($M = 102$, SD = 14.93) groups under study ($p < 0.01$). The results also indicate that there exists no significant relationship between cognitive style and working memory.

CONCLUSION: Adolescents with SLD was found to be field dependent and has low working memory capacity than adolescents without learning disability. The results reflect the need for developing cognitive interventions to enhance working memory capacity and cognitive style for helping adolescents with learning disability in all areas of their functioning, such that the society benefits as a whole.

Keywords:

Cognitive style, field dependence/independence, learning disability, working memory

Introduction

Education is the knowledge, skill, and overall understanding that individuals attain through a formal educational system for their corresponding success in almost all dimensions of life. Any handicap to such a growth or areas of functioning is a matter of concern to majority of people.^[1]

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Of all the problems that have an implication on educational handicap, academic underachievement is a major issue of all time. Specific learning disability (SLD) is viewed as one among the major hindrances to academic achievement among children, though most often it goes unrecognized because of lack of awareness among teachers and parents as well as limited resources in the community.^[2] SLDs are a generic term that refers "to a heterogeneous group of

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neurobehavioral disorders manifested by significant unexpected, specific, and persistent difficulties in the acquisition and use of efficient reading (dyslexia), writing (dysgraphia), or mathematical (dyscalculia) abilities despite conventional instruction, intact senses, normal intelligence, proper motivation, and adequate sociocultural opportunity.^[3] One of the most recent prevalence studies of SLDs by Nayana and Justine (2018) reported that 10% of school-going children in India have SLD.^[4]

As most of the researches in the arena of learning disability came up with findings indicating cognitive deficits in such children, it becomes crucial for investigating the relationship between cognitive constructs influencing learning disability, related academic achievements as well as those constructs which are modifiable to a great extent. One such construct that had been extensively researched is the cognitive style, which refers to the way individual's structure stimuli so that the world takes on psychological meaning.^[5] Among the different models of cognitive style, field dependency and independency are the dimensions which are proved to be one among the factors influencing an individual's educational achievement.^[6]

Cognitive style is defined as the relatively stable strategies, preferences, and attitudes that determine an individual's typical modes of perceiving, remembering, and problem-solving, and the theory of cognitive style that has been widely researched is the dependence-field-independence cognitive style.^[7]

Field dependence/field independence cognitive style is a construct which refers to individual's ability to recognize or trace out a specific figure embedded in a complex background. Individuals who are capable of tracing the embedded figures to a great extent fall under the field-independent category and those who cannot trace out these figures to an appreciable extent fall under field-dependent category.^[8]

Field-independent learner performs exceptionally well in classroom tasks involving analysis, attention to details, and other activities which require concentration. On the other end, field-dependent learners are found to be more successful than the independent one in everyday activities like better ability in language use yielding to good interpersonal communication skills beyond the constraints of the classroom.^[9]

From prior empirical evidences, it was also found that based on the cognitive style, there is a difference in student's academic performance.^[10] The inclusion of a comparative group without learning disability in this study was, therefore, to find out if there is any difference

in the cognitive style dimension between adolescents with and without SLDs which could influence their academic performance.

The cognitive processes of children with learning disability have significant influences on their learning processes. One of the most addressed areas of cognitive functioning in specific learning disabled is the deficits in working memory functioning. Working memory can be conceptualized as a short-term storage component with a capacity limit that is heavily dependent on attention and other central executive processes that make the use of stored information or that interact with long-term memory.^[11] The issues manifested because of deficits in various memory processes are low academic skills.^[12] In dyslexia, for example, common deficits found were in phonological processing, and working memory (verbal). Intervention programs addressing these deficit areas have shown significant improvements among poor readers.^[13] Researches carried out in the area of dyscalculia are not as extensive as that in dyslexia. Still, research evidences indicate that there exist deficits in visual and verbal working memory and executive function. The accompanying difficulties include issues with fluency, problem-solving, and number sequence.^[14]

Empirical evidences have found that the overall learning behavior is greatly influenced by the interaction of cognitive style and working memory abilities.^[15] Therefore, the ground on which the research questions were framed for this study focused on finding a relationship between both these cognitive constructs to academic performance specifically in adolescents with SLD. Previous studies have not tried to explore in depth the correlation among these concepts and in particular to learning disability population. The current study design also incorporates a comparative group comprising adolescents without any learning disability so as to give more sound empirical evidence to the results obtained. Such an attempt has not been done previously in researches. Thus, the intended outcome of this study focuses on contributing to the educational interventions for students with learning disabilities as well as their age-matched counterparts in their academic performance.

Despite earlier contention by researches that cognitive style is more of a stable characteristic, empirical evidences on the modifiability of cognitive style, especially of dependent style, are found through prior researches.^[16] Cognitive intervention strategies found to be effective in the past included matching the teacher-learner cognitive style, but the strength and the extent of the effectiveness of these methods are not documented well, thus raising the ambiguity in the relationship between cognitive style dimensions and academic achievement, various reasons

behind variation in cognitive style, the modifiability of certain innate cognitive constructs, and the degree of effectiveness of such modification. The number of studies addressing these questions being very limited so far, this study also aims at providing new insights to educationalists and clinicians for developing new strategies for improving in these areas of functioning as well as adding on to the existing intervention techniques.^[17]

Materials and Methods

Study design and setting

The present study adopted a correlational research design, and the study was conducted in four educational institutions in Karnataka and Kerala states of India.

Study participants and sampling

The study participants were adolescents diagnosed with specific disability and adolescents without any specific disability. All the participants in the learning disability group were drawn from S R Chandrasekhar Institute of Speech and Hearing, Bangalore, and Spell Learning Centre, Thrissur, who are diagnosed with SLD by a professional team of clinical experts. The comparative group included adolescents without SLD drawn from two private schools in the same cities. The matching of the groups was done with respect to age (12–16 years). The sample size for both the groups was 60 (30 with SLD and 30 without SLD). The sampling method adopted by the researcher was purposive sampling method. Adolescents diagnosed under the major subtypes of learning disability such as dyscalculia and dyslexia were included in the study. Adolescents diagnosed with learning disability along with other comorbid conditions such as attention deficit disorders, below-average mental ability, and any of the pervasive developmental disorders as well as those with learning disability receiving remedial intervention for more than 4 years were excluded from the study.

Data collection tool and technique

Embedded Figures Test

The Indian adaptation of Embedded Figures Test (EFT) was developed by Nigam (1997). It is a perceptual test or a sort of personality test which was developed with the aim of assessing an individual's cognitive style of field independency–dependency. The test helps to measure perceptual ability, general intelligence, learning ability, sociability, and certain traits of personality. EFT is found to have test–retest reliability of 0.72 and split-half reliability of 0.76 and validity is found to be 0.79.

Wechsler Intelligence Scale for Children-Fourth Edition

The first edition of Wechsler Intelligence Scale for Children (WISC) was developed by Wechsler in 1949

and the fourth edition was revised in the year 2003. It measures the intellectual ability of children aged 6–16 years. Although the full version of the scale composes of 15 subtests, only 10 are considered core and more often used when testing intelligence. In the case of learning-disabled children, the five complementary tests are used in a way to compensate for their poor performance in core subtest and find out the overall IQ profile. Working memory is one among the four indices of IQ in WISC IV. Digit span and working memory index are the two-core subtests of working memory index. The average split-half reliability coefficients ranged from 0.70 to 0.90, and the majority of the subtest scored within the range of 0.81 to 0.90, therefore assuring good reliability.

A formal permission and consent were taken from the authorities of the institution and parents for conducting the study and collecting data from participants. Rapport was established with the participants who met the inclusion criteria and their respective sociodemographic data were collected and recorded. Measurement tools such as EFT and WISC IV were administered on those participants individually by the researcher. Their responses were recorded in the recording form prepared by the researcher as per the manual. EFT required the test taker to identify and trace simple forms (i.e., shapes) that are embedded within more complex forms. The test material consists of ten cards, and one trial card. In each card, there is a design on the left side of the card. There are four alternative complex designs on the right side of the card. In one of the designs, the design on the left is hidden, which the participant needs to perceive. When administered, those participants who exhibit high levels of field dependence found it difficult to overcome background elements in the figure for formulating judgments. In general, the main purpose behind administering WISC IV among the adolescent population is to find out their intelligence level. If the child has got an average level of intelligence, only then, they proceed with further screening for learning disability. Here, the participants were provided with the three subtests from WISC. Those were the digit span, letter-number sequencing, and arithmetic which give us the aggregate score of the participant's verbal or auditory working memory. In all the three subtests, the participants were asked to carefully listen to the instructions provided verbally and perform few mental processing. Digit span and letter-number sequencing are the core subtests of working memory whereas arithmetic is a supplementary subtest which is administered if the need arises based on child's ability to perform the core subtests. The completed response sheets and the collected quantitative data were scored according to the norms and statistical analysis.

Ethical consideration

The ethical approval for the study was obtained from the Central University of Karnataka. The data collection was done by taking into consideration the major ethical guidelines of research review boards such as maintaining the anonymity of the participants and keeping results confidentially. Participants were given the right to withdraw from the study if they wished to and they were not harmed in any manner.

Data analysis

Statistical analysis of the data collected was done using the software IBM SPSS version 25 (USA). The data were analyzed using independent sample *t*-test and Pearson's product-moment correlation.

Results

Table 1 shows the demographic details of participants with respect to the group which they belong to, gender, and place of residence. The frequency obtained in gender for males is 20 and for females is 10 in the learning-disabled group with a corresponding percentage of 66.70% and 33.30%, respectively. In the nonlearning-disabled group, the frequency of males is 15 and females is 15 with a corresponding percentage of 50% for both genders, respectively. Among the learning-disabled group, 63.30% and 36.70% hailed from urban and semi-urban areas with corresponding frequencies 19 and 1 respectively. For the non-learning-disabled group, equal number of participants were from urban and semi-urban areas with a frequency of 15 in each group. There were no representation of participants from rural areas for the current study.

From the table, it is also observed that the researcher included adolescents with SLD in the age range between 12 and 16 years with the corresponding frequencies 9, 4, 9, 3, and 5 and percentage 30%, 16.70%, 30%, 10%, and 13.30%, respectively, and the same way researcher included adolescents without any SLD in the age range between 12 and 14 years with the corresponding frequencies 1, 9, and 20 and percentage 3.40%, 30%, and 66.60%, respectively.

Table 1 also shows the descriptive statistics of sample mean and standard deviation (SD) with respect to age. From the table, it is observed that the mean age of the sample is 13.7 and SD is 1.4.

Table 2 shows the comparison of cognitive style and working memory scores with respect to the two groups of participants, namely learning-disabled group and nonlearning-disabled group. Results show that there is a significant difference in the scores of cognitive

style dimensions between adolescents with learning disability (mean = 11.6, SD = 6.52) and without learning disability (mean = 25.2, SD = 7.33). The obtained *P* value is 0.000 ($P < 0.01$) and *t*-value is 7.59, and results are significant at 0.05 level.

From the table, it can also be observed that there is a significant difference in the working memory between adolescents with learning disability (mean = 66.7, SD = 19.26) and without learning disability (mean = 102, SD = 14.93). The obtained *P* value is 0.000 ($P < 0.01$) and *t*-value is 7.87, significant at 0.05 level.

Table 3 shows the correlation value of variable cognitive style with working memory. From the table, it can be observed that there exists no significant relationship between the cognitive style and working memory ($r = -0.010$). This implies that the cognitive style

Table 1: The distribution of sociodemographic characteristics of participants

Variables	Learning-disabled adolescents ($n=30$), n (%)	Nonlearning-disabled adolescents ($n=30$), n (%)
Gender		
Male	20 (66.70)	15 (50)
Female	10 (33.30)	15 (50)
Total	30	30
Place of residence		
Urban	19 (63.30)	15 (50)
Semi-urban	11 (36.70)	15 (50)
Rural	0	0
Age		
12	9 (30)	1 (3.40)
13	4 (16.70)	9 (30)
14	9 (30)	20 (66.60)
15	3 (10)	0
16	5 (13.30)	0
Mean age	13.7	
SD	1.4	

SD=Standard deviation

Table 2: Independent sample *t*-test value between learning-disabled and nonlearning-disabled groups in cognitive style and working memory

Variables	Groups	<i>n</i>	Mean	SD	<i>P</i>	<i>t</i>
Cognitive style	LD	30	11.6	6.52	0.000	7.59*
	NLD	30	25.2	7.33		
Working memory	LD	30	66.7	19.26	0.000	7.87*
	NLD	30	102	14.93		

*Significant at 0.05 level, $P < 0.01$. LD=Learning-disabled, NLD=Nonlearning-disabled, SD=Standard deviation

Table 3: Correlation table showing the correlation between cognitive style and working memory of adolescents with learning disability ($n=30$)

Variable	Working Memory (<i>r</i>)
Cognitive style	-0.010

dimensions of field dependence and independence are not correlated to the functioning of working memory.

Discussion

According to the scores obtained in the EFT and its interpretation norms, the scores obtained by the learning-disabled group fall in the category of field-dependent cognitive style while those in the other group obtained comparatively higher scores, with majority of them falling under the field-independent category and a few in field-dependent category. This result is in consistent with the results found in a study conducted by Sharma and Ranjan in 2018, stating that field-independent students are better in learning and comprehension.^[10] Among the student population, those who find it easier to carry out this task and get good scores, i.e., who are field independent, are likely to perform better in school since school performance is also based on the ability to selectively attend to a range of information presented.^[18,19]

Research findings also point out the link between working memory and cognitive style dimension,^[20] such that learners with holistic learning style (field-dependent learners) have significantly smaller working memory than learners with serial learning style (field-dependent learners).^[21] From the present study, learning-disabled adolescents were found to have significantly low working memory capacity than their normal counterparts. Thus, the current findings are in line with the evidences from studies showing the association between cognitive style and working memory functioning.^[20]

Apart from the physiological and cognitive reasons that account for this difference in cognitive style dimension, literature evidences came up with the perspective of teacher–student match or classroom environment, the modification of which is indeed a great intervention implication in modifying a child’s cognitive style.^[22] Learning-disabled children are much more likely to approach school with a field-sensitive orientation. When classroom interaction happens between a field-independent teacher with a field-sensitive child, it can be a frustrating experience for teacher and student alike. The probable reasons could be the lack of student’s comprehending capacity to the specific instruction by the teacher when there is a mismatch between student- teacher cognitive style.

Further, this would also lead to teacher not comprehending the child’s failure to communicate or the unusual needs.

From the results, it was also observed that there is a significant difference in the scores of working memory between the learning-disabled and nonlearning-disabled

groups. In the present study, adolescents with learning disabilities showed lower performance in the working memory test than the comparable group of those without any kind of learning disabilities. This result is in consistent with the previous research findings carried out among this population.^[23-26] Prior studies have tried to explore the neural and cognitive basis of learning disability, and it was found that reading disability (dyslexia) is associated with deficit in phonological working memory and central executive functioning.^[27]

Apart from the general understanding of working memory deficits in individuals with learning disability grounded on some cognitive deficits, few researchers came up with the finding that working memory cannot be viewed entirely on the grounds of a capacity deficit, rather for some children with learning disabilities, this could be primarily a strategy deficit.^[28] That is, children with a learning disability often possess sufficient working memory resources but fail to apply effective strategies spontaneously or consistently, resulting in learning failure. Further researches are needed to confirm as this aspect as well as plan intervention taking into account the strategy deficit.

In the current study, the researcher tested the correlation between cognitive style and working memory with the aim of finding out if field dependency and independency are the reasons behind low working memory in learning- disabled students compared to the other group under study.

Since such a relationship was not found from the present study, which may be further due to reasons such as small sample size and heterogeneity of the sample collected, this difference found in working memory capacity cannot be attributed to difference in cognitive style dimensions of field dependence/independence. However, there is also evidence of difference in cognitive style dimension found between these two populations. Therefore, this difference can be due to some other unknown cognitive mechanisms or some other variables or factors which interact and influence both these variables other than those which are empirically found out.

The correlation analysis was done to find out whether there is any relationship between the variables cognitive style and working memory and it was found that there is no significant relationship between the scores of cognitive styles and working memory. In the present study, the researcher tried to explore the relationship between these variables as an implication for intervention strategies among the learning-disabled population. Hindal, Reid, and Badgaish in 2009 through their research on working memory, performance, and learner characteristics came up with the result that with respect to all

learning characteristics including field independency and dependency, the learners' working memory is significantly correlated.^[29] This correlation between cognitive style and working memory is attributed to various reasons such as the working efficiency of the brain's perceptual filter, the way working memory processes as well as stores information and the way in which this information is being used by long – term memory.^[29] Thus, it can be viewed that a contradictory result yielded from the present study could be because of the peculiarity of the sample under consideration, i.e., the cognitive characteristics of learning-disabled individuals.

From various researches conducted among the learning-disabled population, it is found that the working memory capacity of these individuals is low compared to their normal age-matched counterparts.^[27] Further, the efficiency of perception filter and storage of information to long-term memory is influenced by working memory capacity. The interaction of three of these systems is essential in predicting to what extent an individual can process information available at hand and perceive it in the correct way according to the task demand.^[29] The failure of which may produce cognitive overload in these individuals that they adopt a cognitive style which is characterized by holistic analysis of an information (field dependence) rather than analytically viewing (field independence) the details of the particular information.

Limitations of the study

The study could reveal significant aspects relating to the cognitive style dimension and working memory capacity of adolescents with learning disability even though the study acknowledges several limitations in the process of completion. The sample size taken for the study is limited and further the number of samples for each group based on age, gender, and other sociodemographic details was not comparable. If this could have been taken care of, a wide range of data could have been collected and the accuracy of results could have been further escalated.

Furthermore, if data would have been collected from a comparable group matched on the basis of IQ scores, the influence of intellectual capacity on both the variables under study could have been controlled.

Recommendations of the study

The present study can be taken forward in order to compensate the limitations and to yield more findings with interventional implications. Further researches can be conducted on the basis of this study for detailed and wide range of data. The present study can be made effective through the following measures:

The study can be replicated on large samples so that the results can be generalized. There is scope to study

cognitive construct other than working memory which has got strong influence on the cognitive style dimension. This further helps in planning intervention among learning-disabled population to improve their cognitive style of field dependency to a degree which can benefit them in their academics. The study can also be done solely among adolescents without any learning disability and help them in their career planning based on their capabilities.

Implications of the study

Education revolves around the acquisition of knowledge and learning of skills, and as such, it is an indispensable rite of passage for anyone wishing to join the modern society and function well in it. Educational handicaps go on to cause bigger and bigger hurdles in the lives of those suffering from it. Hence, there is a compelling need for more and more studies aimed at understanding these handicaps better. Thus, the present study was conducted with the aim of numerous implications both in research and intervention purposes. Adolescence is the period of development wherein, according to Piaget's stages, formal operational stage begins. The hallmark cognitive development of this stage is that an individual starts to think and reason logically. Therefore, learning about the specific cognitive construct among learning-disabled adolescents which have got educational implication is very crucial for planning interventions to help them academically.

From the study, it is found that adolescents with learning disability are found to be field-dependent; this indicates that they lack the ability to analytically view a piece of information presented to them. This is a very important skill that they need to develop as they move to higher classes, as well as in almost all the practical situations. Therefore, the result of this study implicates the need for improving this aspect of adolescents with learning disability so that it would be beneficial for them in all areas of functioning. Furthermore, it is found that the intervention plans for learning-disabled individuals are largely based educational/remedial training. Thus, the result obtained from this study indicating the low working memory capacity among adolescents with learning disability compared to their normal counterparts points out specifically the need for including more cognitively based intervention plan for learning-disabled population along with educational intervention so that enough brain stimulations acquiring from cognitive training can further help them improve in academics.

Conclusion

The study provides the evidence that there is a difference in the cognitive style dimension of field dependence and field independence and working memory between

adolescents with SLD and without any SLD. Adolescents with SLD were found to have field-dependent cognitive style dimension and low working memory capacity and also the individual's cognitive style dimension is not related to the working memory functioning.

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Conflicts of interest

There are no conflicts of interest.

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