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Comparison of the Cognitive Processing Structures of Students Diagnosed With Attention Deficit Hyperactivity Disorder, and Specific Learning Disorder According to Cognitive Assessment System Scores

ABSTRACT

Objective: The aim of this study is to compare the cognitive processing structures of students diagnosed with attention deficit hyperactivity disorder (ADHD) and specific learning disorder (SLD). AD and HD in this study are grouped separately. There are no students diagnosed as having two subgroups together.

Methods: A total of 105 students, 35 AD, 35 SLD, and 35 HD, who were applied to the Cognitive Assessment System (CAS) and diagnosed by an expert, were selected as the sample. The students were evaluated according to their CAS full scale scores and the results of planning, attention, and simultaneous and successive cognitive processing areas.

Results: It was examined whether the cognitive processing areas of the students differed among the diagnosis groups by one-way analysis of variance. Although no significant difference was found in the cognitive processing full scale score among the diagnosis groups, significant differences were found between the cognitive processing areas among the diagnosis groups. The planning scale scores of the students in the HD diagnosis group were lower than the other groups, the attention scale scores of the students in the AD diagnosis group were lower than the HD and SLD diagnostic groups, and simultaneous and successive cognitive processing scores of the students in the SLD diagnosis group were lower than the scores of the students in the HD and AD diagnosis groups. In our study, it was determined that students in different diagnosis groups have different cognitive structures. For this reason, it is necessary to prepare and apply different cognitive intervention programs suitable for each diagnostic group.

Conclusion: Determining the cognitive processing areas of students in different diagnosis groups will guide the creation of the content of cognitive intervention programs.

Keywords: Needs assessment, specific learning disorder, attention deficit hyperactivity disorder

Introduction

Naturally, learning styles and learning problems of students with different cognitive structures will also be different. Recognizing students' cognitive structures and determining the cognitive processing areas that make their learning difficult and their educational needs will enable them to benefit from the educational environment at a high level because it will be possible to prepare faster and more effective cognitive intervention programs by analyzing the cognitive processing characteristics of the students.[1]

According to Naglieri and Pickering,[2] learning has been described as a complicated event in which the teacher, the setting, the curriculum, the family structure, the way a child thinks, and many other factors all lead to academic success or failure. Sometimes, the mental and cognitive processing characteristics of the student can cause learning problems. Therefore, it is necessary to know the cognitive characteristics of the student and his/her strengths and weaknesses in cognitive processing areas. As well as recognizing the strengths and weaknesses of a student's cognitive processing areas, the coordination between these cognitive processing areas also plays an important role in learning performance. Even if a student shows high performance in any of the cognitive processing areas, he/she will not be

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able to show his/her real performance when there is incoordination between these cognitive processing areas.[3] According to Luria,[4] although different processes of the brain are referred to as different functions, they are also explained as structures that work together and affect each other. Luria[4] believes that the brain functions more as a collection of interrelated parts. A neuropsychological test-based approach aids in testing on the basis of what is known about the brain. Thus, complex cognitive processes become observable at the brain level. Neuropsychological tests are objective tools that describe complex information processing phenomena quantitatively with numbers.[5] Therefore, there are many tests developed for the evaluation of cognitive processes. Among these, two batteries, which are widely used in the world, have recently been used in our country. The Wechsler Intelligence Scale for Children (WISC)-IV, based on Cattell-Horn-Carroll intelligence theory, and the Cognitive Assessment System (CAS), based on the Planning, Attention-Arousal, Simultaneous and Successive (PASS) theory, are used in the evaluation of cognitive processes.[6] The planning scale results of CAS provide assessment data to the practitioners in determining how successful students are in self-controlling, controlling their impulses, organizing their cognitive activities, and self-programming. The attention scale provides data to practitioners to determine how successful a student is in selective attention, turning to the appropriate stimulus, and resisting unsuitable stimuli. Whereas the attention scale results of CAS are considered in attention deficit (AD), the attention and planning scales are especially important when hyperactivity is considered. Studies have determined that the memory problems of students with specific learning disorder are related to the performance of the successive cognitive processing area. It has been determined that successive and simultaneous cognitive processing performance is related to the student's reading comprehension. For this reason, it is important to determine the successive and simultaneous cognitive processing performances of students with specific learning disorder (SLD) problems.[7] According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, attention deficit hyperactivity disorder (ADHD) has three subtypes: AD, hyperactivity and/or impulsivity, and combined type (American Psychiatric Association, 2013).[8]

MAIN POINTS

- *The planning scores of the students with a diagnosis of hyperactivity disorder, the attention scores of the students with the diagnosis of attention deficit, and the simultaneous and successive cognitive processing scores of the students with specific learning disorder are low.*
- *The contents of the cognitive intervention programs to be organized for each of the diagnosis groups of attention deficit, hyperactivity disorder and specific learning disorder should be structured by considering the cognitive processing areas that need to be supported.*
- *Performance loss in a cognitive processing area is reflected in a similar way to the CAS full scale score, which reflects the entire cognitive processing domains. This situation shows that instead of focusing on general scores in attention deficit, hyperactivity disorder and specific learning disorder diagnosis groups, it is necessary to focus on which cognitive processing area is experiencing performance loss.*

In this study, besides SLD, two subtypes of ADHD, AD and hyperactivity/impulsivity disorder, were studied. For this reason, HD is used for hyperactivity/impulsivity disorder. Conducting examinations on students with problems such as SLD, AD, and HD will contribute to the development of knowledge and understanding on these issues, better recognition of these students, better understanding of their needs, planning of different applications that contribute to their development, and structuring of cognitive intervention programs.[9] Thus, taking into account the different features of each problem area will ensure that the cognitive structure characteristics required for the planning and implementation of intervention studies will be determined.

Methods

This research is a descriptive research study aimed at determining the current situation as it is, and in this research, a general scanning model was used. In this study, there were a total of 105 students between the ages of 62 and 120 months, with a mean age of 104.84 months, diagnosed with SLD, AD, or HD by a psychiatrist.

The process started with the selection of psychologists and psychological counselors with CAS application certificates as a test team. Testers who carried out CAS applications on a voluntary basis worked in guidance research centers, hospitals, clinical settings, rehabilitation centers, or consultancy centers. The data for the research were collected between 03.07.2020-02.10.2020 in the province of İstanbul. The diagnoses of the children participating in the study were made by three different psychiatrists working in a clinical setting. First, an individual interview was held with the psychiatrists, and then written consent was obtained. Diagnoses were made by psychiatrists according to DSM-5 criteria. These children were reached through psychologists and psychological counselors working alongside psychiatrists. The private information about the children was obtained directly from the relevant psychiatrist with the permission of the family. Then children's CAS applications were carried out by psychologists and psychological counselors with CAS certification in a special counseling center, whose authorization was submitted to the ethics committee. The children were chosen from among those who applied to a psychiatrist for the first time, who had not been treated before.

An equal number of students were selected from each diagnostic group. Verbal consent from all students and written consent from their parents were obtained for participation in the study. The research was approved by the İstanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee (number 2020/95 on June 12, 2020).

In this study, CAS was used to collect data. CAS was carried out in a private counseling center, whose permission certificate was submitted to the ethics committee by psychologists and psychological counselors working with a psychiatrist. CAS is a tool developed by Naglieri and Das, and Turkish adaptation studies were started in 2003 by Ergin.[10] CAS was developed to evaluate the cognitive processing domains of children aged 5 to 17, based on the PASS theory. CAS consists of four scales and three subtests on each scale, for a total of 12 subtests. The average of the subtest scores in each of the four different PASS scales is 10, and the standard deviation is three. Each scale is combined to give the standard score, with a mean of 100 and

a standard deviation of 15. Reliability coefficients were found to be between r = 0.60 and r = 0.99 in the studies. Considering the calculated Pearson Product Moments Correlation Coefficient, it was reported that there was a significant relationship between all subtests at the $P < .001$ level, and the relationship between the four CAS scales was significant.

As a result of the single-sample Kolmogorov-Smirnov test, which was conducted to determine whether the scores obtained in the context of both CAS full scale and individual CAS scales show normal distribution, the difference of the distributions from the normal distribution was not found significant (CAS full scale: z = 0.938, $P > .05$; planning: z = 0.830, $P > .05$; simultaneous: z = 1.243, $P > .05$; attention: z = 0.844, $P > .05$; successive: z = 0.656, $P > .05$). According to these findings, it can be said that CAS scores have a normal distribution feature.

Statistical Analysis

To test the hypotheses, the independent (unrelated) group *t*-test and one-way analysis of variance (ANOVA), which are among the parametric statistical techniques, were applied.[11] SPSS 16 (SPSS Inc.; Chicago, IL, USA) for Windows was used for statistical analysis, and a significance level of at least .05 was sought in all analysis.

Results

Whether the scores obtained from the CAS full scale of the students participating in the study and from the CAS scales representing the four PASS cognitive processing domains differ among the diagnosis groups was examined by one-way ANOVA, one of the parametric techniques.

As seen in Table 1, as a result of the one-dimensional ANOVA applied to determine whether the CAS full scale score and CAS scale scores differ significantly according to the diagnostic variable, there was no significant difference in the CAS full scale score ($P = .765$), but the lowest in all scales. There was a significant difference at $P < .001$ level. Levene's test was carried out to determine which post hoc tests will be applied to determine which groups have these differences. According to these test results, LSD in planning and attention scales and Tamhane's post hoc analysis in simultaneous and successive scales were applied and the results are shown in Table 2.

According to the results of the complementary post-hoc analysis, techniques applied to determine among which groups the CAS scale scores differed in terms of the diagnostic variable. Planning scores of the students diagnosed with HD were found to be lower than the students diagnosed with both ADD ($P = .000$) and SLD ($P = .000$). The planning scores of the students diagnosed with AD were found to be lower than the students diagnosed with SLD ($P = .047$). Simultaneous and successive scores of the students diagnosed with SLD were found to be lower than the students diagnosed with both AD ($P = .000$) and HD ($P = .000$). Attention scores of students diagnosed with AD were lower than those diagnosed with both HD ($P = .000$) and SLD ($P = .000$). Attention scores of students diagnosed with HD were found to be lower than those diagnosed with SLD ($P = .003$).

Discussion

According to the findings obtained from the students participating in this study, no significant difference was found in the CAS full scale score compared with the diagnostic groups. The CAS full scale score is a standard score based on the combination of planning, attention, simultaneous, and successive cognitive processing scales with equal weight. With the CAS full scale score, a general measure of cognitive functions is provided and the general level of the individual's cognitive functions is shown. The fact that the CAS full score does not differ among the diagnostic groups is consistent with the interpretation that

Table 1. Results of One-Way ANOVA of CAS Full Scale and CAS Subscale Scores

	N, Mean (SD)			ANOVA results				
Scale	**Group**	**N**	**Mean (SD)**	**Predictor**	**Sum of squares**	**df**	**Mean square**	**F**	***P***
Planning	AD	35	96.91 (12.001)	Between G	4839.390	2	2419.695	22.684	.000
	HD	35	85.66 (8.055)	Within G	10880.171	102	106.668		
	SLD	35	101.89 (10.529)	Total	15719.562	104			
	Total	105	94.82 (12.294)						
Simultaneous	AD	35	108.26 (10.864)	Between G	6983.790	2	3491.895	34.781	.000
	HD	35	106.63 (11.561)	Within G	10240.457	102	100.397		
	SLD	35	90.20 (7.037)	Total	17224.248	104			
	Total	105	101.70 (12.869)						
Attention	AD	35	83.77 (7.216)	Between G	5050.343	2	2525.171	24.142	.000
	HD	35	93.31 (11.172)	Within G	10668.857	102	104.597		
	SLD	35	100.71 (11.701)	Total	15719.200	104			
	Total	105	92.60 (12.294)						
Successive	AD	35	99.51 (9.942)	Between G	2324.705	2	1162.352	6.956	.001
	HD	35	102.43 (14.409)	Within G	17044.857	102	167.106		
	SLD	35	91.31 (13.960)	Total	19369.562	104			
	Total	105	97.75 (13.647)						
CAS FS	AD	35	96.00 (9.026)	Between G	50.990	2	25.495	0.269	.765
	HD	35	95.63 (11.040)	Within G	9664.343	102	94.748		
	SLD	35	94.37 (8.994)	Total	9715.333	104			
	Total	105	95.33 (9.665)						

Abbreviations: AD, attention deficit; CAS, Cognitive Assessment System; FS, full scale; HD, hyperactivity disorder; S, score; SLD, specific learning disorder.

Table 2.The Results of Post-Hoc Analysis According to the Diagnostic Variable of PASS Scales

	Diagnostic (i)		Diagnostic (j)	Mean difference (i-j)	Std. error	*P*
Planning	(LSD)	AD	HD	11.257	2.469	.000
			SLD	-4.971	2.469	.047
		HD	ADD	-11.257	2.469	.000
			SLD	-16.229	2.469	.000
		SLD	AD	4.971	2.469	.047
			HD	16.229	2.469	.000
Simultaneous	(Tamhane's)	AD	HD	1.629	2.682	.906
			SLD	18.057	2.188	.000
		HD	AD	-1.629	2.682	.906
			SLD	16.429	2.288	.000
		SLD	AD	-18.057	2.188	.000
			HD	-16.429	2.288	.000
Attention	(LSD)	AD	HD	-9.543	2.445	.000
			SLD	-16.943	2.445	.000
		HD	AD	9.543	2.445	.000
			SLD	-7.400	2.445	.003
		SLD	AD	16.943	2.445	.000
			HD	7.400	2.445	.003
Successive	(Tamhane's)	AD	HD	-2.914	2.959	.697
			SLD	8.200	2.897	.019
		HD	AD	2.914	2.959	.697
			SLD	11.114	3.391	.005
		SLD	AD	-8.200	2.897	.019
			HD	-11.114	3.391	.005

Abbreviations: AD, attention deficit; CAS, Cognitive Assessment System; HD, hyperactivity disorder; LSD, least significant difference; sig., significance; SLD, specific learning disorder.

the cognitive processes defined with different characteristics reflect a functional whole, as emphasized by Luria.[4] Performance loss in a cognitive processing area is reflected similarly in the CAS full scale score, which reflects the entire cognitive processing areas. This relationship is also similar to WISC-III general IQ scores.[10] This situation shows that instead of focusing on general scores in diagnostic groups, we should focus on which cognitive processing areas experience performance loss. According to these findings, whereas the planning scores of the students diagnosed with HD were lower than the other two groups, their attention scores were lower only than the group diagnosed with SLD. Similarly, the performance of children with ADHD in the planning scale and subtests was found to be significantly lower in studies.[12] Planning is a neurocognitive skill used to identify, select, and implement strategies to solve problems for which initiation, self-monitoring, and self-correction are particularly important.[13]

In addition, the problem of hyperactivity and AD plays a major role in unavoidable behavior, and this situation is significantly related to the planning cognitive process. In short, planning and attention are defined as separate but intertwined cognitive processes.[14] The CAS planning results in these research findings also reflect this complex relationship. The planning scores of the students in the HD diagnosis group are lower than the scores of the students in both the AD and SLD diagnostic groups. In addition, the planning scores of the students in the AD group are lower than the scores of the students in the SLD group.

According to the analyses completed within the scope of this research, it was determined that the attention scores of the students in the AD group were lower than the scores of the students in the SLD and HD groups. In addition, it was found that the attention scores of the students in the HD diagnosis group were lower than the scores of the students in the SLD group. This finding supports the definition of planning and attention as separate but intertwined cognitive processes.

The CAS attention scale evaluates whether students can perform in a focused manner and selectively against a stimulus or stimuli, within a certain period of time, without disconnecting from the stimulus and making a special effort.[10] These cognitive functions, measured by the attention scale, embody the problems that students diagnosed with AD experience in the attention area.

Some studies have shown that the attention scale is sensitive to the AD problem area and gives meaningful results.[15,16] These findings may shed light on cognitive intervention programs to be structured to support students with AD problems. As a result of the analyses completed within the scope of this study, concurrency performance, which is a form of information processing, was found to be lower in students with SLD than other diagnostic groups.

Simultaneousness has a high level of association with academic skills such as reading comprehension, problem solving, and using numerical concepts.[10] In the literature, a high level of relationship between concurrent cognitive processes and these academic fields has been stated. Simultaneous cognitive processes were found to be associated with SLD in many research findings.[10,17-19] These studies confirm our findings. As a result of this study, it was found that the simultaneous and successive scores of students in both the HD and AD groups were higher than the scores of the students in the SLD group. This result is

supported by other studies. It is compatible with the view that inadequacies in successive cognitive processes in students in the SLD group who have reading difficulties may be related to problems in the definition of sounds and thus may play a role in insufficient vocabulary.[4]

It has been observed that the successive subtests provide important information for the identification of students with significant learning difficulties in reading and analysis (failure to fulfill phonological skills).[17-22] Comprehensive evaluations should be made to define SLD. Children with SLD need individualized interventions based on their specific learning needs.[23] The findings obtained from the research can help researchers to meet these needs.

In our study, it was determined that students in different diagnosis groups have different cognitive structures. Therefore, it is necessary to prepare and apply different cognitive intervention programs suitable for each diagnostic group. In addition, it is recommended to eliminate the inconsistencies between the cognitive processing areas, strengthen the weak areas by making use of the strong cognitive processing areas, and support the holistic development for the coordination of the cognitive processing areas. In the formation of cognitive intervention programs, rather than focusing on a single cognitive processing area, it is thought that it would be beneficial to consider the cognitive processing areas that affect each other together and to add emotional problems as a variable to future research.

Ethics Committee Approval: *Ethics committee approval was received for this study from the Ethics Committee of İstanbul University-Cerrahpaşa Social and Human Sciences Research (Approval Date: June 12, 2020; Approval Number: 2020/95).*

Informed Consent: *Verbal consent from all students and written consent from their parents were obtained for this study.*

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