

Analyzing the WISC-R In Children with ADHD: The Predictive Value of Subtests, Kaufman, and Bannatyne Categories



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SUMMARY

Objective: The aim of this study was to evaluate the predictive value of Intelligence Quotient scores (IQs), subtests of Wechsler Intelligence Scale for Children-Revised (WISC-R), and the Kaufman's and Bannatyne's categories scores in attention deficit hyperactivity disorder (ADHD). In addition, this study was designed to examine the difference of some neurocognitive skills for children with ADHD and their unaffected peers using the WISC-R subtests.

Method: WISC-R's subtest and IQ scores, and scores of Kaufman's and Bannatyne's categories of the children who were diagnosed with only ADHD were compared with the same scores of the children in the healthy control group (N= 111) and the ADHD with comorbid group (N= 82).

Results: It was found that the subtest scores (vocabulary, comprehension, digit span, picture completion, and block design) of the children with only ADHD and ADHD with comorbidity were significantly lower than the healthy group. In addition, object assembly subtest scores of the children with only ADHD were lower than the control group. Subtests of comprehension (Wald = 5.47, df = 1, p=0.05), digit span (Wald = 16.79, df = 1, p=0.001), and picture completion (Wald= 5.25, df= 1, p=0.05) were able to predict ADHD significantly. In this study, the categories of freedom from distractibility (Wald = 8.22, df = 1, p=0.01) and spatial abilities (Wald = 12.22, df = 1, p<0.0001) were also predictive for ADHD.

Conclusion/Discussion: Problem-solving abilities in social processes, auditory short-term memories, visual-spatial abilities, and visual configuration abilities of the children with ADHD were lower than their healthy peers. It was thought that in WISC-R's profile analysis, the categories of freedom from distractibility and spatial abilities could be distinctive in ADHD diagnosis.

Key Words: Attention deficit and hyperactivity disorder, WISC-R, Wechsler. Intelligence Scale for Children-Revised, child, adolescent, mental health

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is one of the most common neuropsychiatric disorders in children (Lange et al. 2014). Two main symptoms of ADHD are inattention and hyperactivity-impulsivity (APA 2013). In addition to these, social, emotional, behavioral problems, and cognitive impairments such as executive dysfunctions are common in ADHD (Spencer et al. 2007, Tsai et al. 2013). Executive functions is a concept used for higher brain functions containing goal directed behaviors associated with functions of frontal lobe such as planning, problem solving,

concentration, strategy formulation, monitoring, emotional regulation, choice, selectively attention routing, and suppression of inappropriate response (Rossi et al. 2009, Rubia et al. 2009, Zambrano-Sánchez et al. 2010, Korzeniowski 2011). Individuals with ADHD were also reported to have executive dysfunctions. (Siu & Zhou 2014).

There is no laboratory or specific diagnostic test to confirm the diagnosis of clinically diagnosed ADHD (Ercan et al. 2001). Nowadays, in clinical practices for diagnosis of ADHD, parents and teachers assessment and behavior rating scales are used (American Academy of Child and Adolescent Psychiatry 2007, Ercan et al. 2001). Another source of

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information to which clinicians refer is Wechsler Intelligence Scale for Children-Revised Form (WISC-R) which provides data related to multiple cognitive functions (Sattler 2002, Devena & Watkins 2012, Evinç & Gençöz 2007). Even if WISC-R was created to measure general intellectual skills, merely subtest scores are interpreted as a measure of an individual's specific neuropsychological characteristics (Campbell & McCord 1999).

WISC-R is an intelligence test, which provides Verbal and Performance Intelligence Quotient (IQ) scores obtained separately, and it consists of two sections, each containing six subtests. In addition, total IQ score is also obtained from WISC-R's completely 12 subtests (10 core and 2 supplementary subtests). In addition to studies dealing with differences between WISC-R verbal and performance scores, there are also studies examining subtests and subtests pattern (profile) analyses derived from subtests and total of some of these subtests (Prifitera & Dersh 1993, Anastopoulos et al. 1994, Mayes et al. 1998, Snow & Sapp 2000, Mahone et al. 2003, Kiriş & Karakaş 2004, Erdoğan-Bakar et al. 2005, Evinç & Gençöz 2007, Öngider et al. 2008).

The most prominent pattern analysis of WISC-R is that formed by Kaufman and Bannatyne classifications. Kaufman (1975), using exploratory factor analysis on the WISC-R standardization sample in his study, found another factor apart from two factors that are by WISC-R. He identified those three factors as "verbal comprehension", "perceptual organization", and "freedom from distractibility". The verbal comprehension factor consisted of information, similarities, comprehension and vocabulary subtests, perceptual organization factor consisted of block design, picture completion, picture arrangement and object assembly subtests and the third factor, called freedom from distractibility, consisted of arithmetic, coding and digit span subtests. According to hypotheses in this model, coding and digit span subtests indicates the presence of inattention, and getting high scores demonstrates an ability to sustain attention (Kaufman 1979, Lufi & Cohen 1985, Wechsler 1991, Faraone et al. 1993, Anastopoulos et al. 1994, Seidman et al. 1997, Mayes et al. 1998).

The Wechsler intelligence scores are also associated with ADHD. The term "ACID" is a pattern, which consists of arithmetic, coding, information and digit span subtests (formed from initial letters of subtests) (Schwean & Saklofske 2005; Devena & Watkins 2012). Individuals diagnosed with ADHD had lower scores in arithmetic, coding, information, and digit span subtests, i.e. ACID pattern (Snow & Sapp 2000). Bannatyne (1974) found four factors including "spatial abilities" (picture completion, block design, object assembly), "conceptual abilities" (comprehension, similarities, vocabulary), "sequential abilities" (digit span, picture arrangement, coding), "acquired knowledge pattern" (information, vocabulary, arithmetic). Considering other studies, arithmetic

subtest replaced picture arrangement subtest, which constitutes the sequential ability (Smith & Watkins 2004).

In a study examining the Bannatyne categories in children with ADHD, children diagnosed with ADHD and SLD had the lowest scores in sequential abilities and the highest scores in spatial ability; however, using this category for differentiating of diagnosis of ADHD was limited (Prifitera & Dersh 1993). The first aim of this study was to investigate the diagnostic value of WISC-R subtests and classifications of Kaufman and Bannatyne derived from these subtests in ADHD. Another aim of the study was to examine some neurocognitive features of children with ADHD through WISC-R subtest scores that are different from their healthy peers.

METHOD

Participants

In this study, psychiatric personal cards of school age children, who applied to Muş State Hospital's Child-Adolescent Psychiatry outpatient clinic, with complaints of distractibility, hyperactivity, and impulsivity were scanned retrospectively in a two-year period. The DSM-IV-Based Disruptive Behavior Disorders Screening and Rating Scale were applied to those diagnosed with ADHD. Those who had WISC-R total IQ scores higher than 80, a digit span supplement subtest, and those without neurological disorder were included in the study. Thus, the study sample consisted of children age 6 to 15 years old, with 101 of whom were diagnosed with ADHD. Eighty two patients were diagnosed with ADHD associated comorbidity, and 111 children were not diagnosed at all. Table 1 shows the other diagnoses of ADHD with comorbidity cases. Of the 82 children with comorbid disorders,

Table 1. Other psychiatric diagnoses of ADHD with comorbidity cases according to DSM-IV.

Comorbid	n	%
Anxiety Disorders	22	26.82
Enuresis	20	24.39
Specific Learning Disorder	19	23.17
Tic Disorder	16	19.51
Conduct Disorder	10	12.19
Depression	9	10.97
Obsessive Compulsive Disorder	6	7.31
Oppositional Defiant Disorder	6	7.31
Stuttering	3	3.65
Encopresis	3	3.65
Eating Disorder	3	3.65
Expressive Language Disorder	1	1.21
Autism Spectrum Disorders	1	1.21
Alcohol-Substance Abuse	1	1.21

50 children had one, 25 children had two, and seven children had three or more comorbid disorders. The healthy control group consisted of children who were admitted to the same hospital outpatient department of pediatrics, with no chronic medical or mental illness. Children and their families volunteered to participate in the study. WISC-R was administered after periods of illness. Informed consent forms were obtained from parents. The sample groups were similar in terms of age and gender. Twenty eight percent of the participants were girls ($n = 28$) and 72 % were boys ($n = 73$) in the ADHD group. Thirty percent of participants in the ADHD + comorbid disorder group were girls ($n = 33$) and 70 % were boys ($n = 78$). The healthy control group consisted of 23 % girls ($n = 19$) and 77 % boys ($n = 63$). The mean ages of the sample groups were 9.16 ($SS=2.09$) for the ADHD group, 9.10 ($SS=2.30$) for the ADHD with comorbidity group, and 9.11 ($SS=2.15$) for the healthy control group.

Instruments

Wechsler Intelligence Scale for Children-Revised (WISC-R):

Developed by Wechsler in 1949, WISC-R was revised in 1974 and became applicable to children between 6 and 16 years old (Wechsler, 1974). Standardization and norms were adapted for Turkish sample by Savaşır and Şahin (1995). WISC-R consists of six verbal subtests (information, vocabulary, arithmetic, comprehension, similarities and digit span), and six performance subtests (picture completion, block design, object assembly, picture arrangement, coding and mazes) with supplement subtests. In addition to these subtests, standard scores, verbal, performance, and total IQ score coefficients were obtained. For these IQs, the average value was 100 and standard deviation was 15. The average of each subtest standard scores was 10 and standard deviation was 3 (Savaşır & Şahin 1995). Kaufman's patterns, which were developed later, were "verbal comprehension" (information, similarities, vocabulary, and comprehension), "perceptual organization" (block design, object assembly, picture arrangement, and picture completion), "freedom from distractibility" (coding, digit span, and arithmetic), and "ACID" (arithmetic, coding, information, and digit span). Bannatyne's patterns were defined as "spatial abilities" (picture completion, block design, and object assembly), "conceptual abilities" (similarities, comprehension, and vocabulary), "sequential abilities" (digit span, arithmetic, and coding) and "acquired knowledge" (information, vocabulary, and arithmetic). In this study, WISC-R scores as well as these pattern scores were included in the analysis.

DSM-IV-Based Disruptive Behavior Disorders Screening and Rating Scale:

This scale was developed for screening disruptive behavior disorders based on DSM-IV criteria by Turgay (1995). The

validity and reliability studies were conducted in Turkey by Ercan et al. (2001), and the scale was completed by the child's parents and teachers.

Procedure

The sample groups contained children who completed WISC-R and DSM-IV-Based Disruptive Behavior Disorders Screening and Rating Scale. All WISC-R tests were administered by the hospital psychologist who was certified for administration and scoring the tests. While the study group consisted of ADHD cases without any comorbid disorder, the first control group consisted of children applied to the pediatric outpatient department. ADHD with comorbidity cases constituted the second control group. Diagnosis of comorbid disorders were made according to DSM-IV.

Statistical Analysis

One-Way Analysis of Variance (ANOVA) method was used to compare WISC-R scores, and Kaufman and Bannatyne classification of groups of ADHD, ADHD with comorbidity, and the control group. The LSD method was used for between-group post-hoc comparisons of significant WISC-R scores as a result of ANOVA. In addition, in order to determine the predictive degree of subtests for ADHD, logistic regression analysis was performed with WISC-R subtest scores. Similarly, a logistic regression model was established using Kaufman and Bannatyne classifications, and patterns associated with ADHD were identified.

RESULTS

ANOVA was conducted to determine significant differences in terms of scores of WISC-R subtests and IQ's among the groups. The findings of comparisons between groups performed with the LSD method are presented in Table 2. Accordingly, as the results of the analysis were examined, it was found that the control group had significantly higher scores on the subtests of comprehension, digit span, picture completion, block design, and performance IQ than both ADHD group and ADHD with comorbidity group. The control group demonstrated a significantly higher score on object assembly subtest than the ADHD group. In addition, the ADHD with comorbidity group had a significantly higher score than the control group on the information subtest, while both the ADHD and ADHD with comorbidity group had a significantly higher score on the block design subtest than the control group. There were no observed significant differences between the three groups in terms of subtest scores of similarities, arithmetic, picture arrangement, coding, verbal, and performance IQ's.

Table 2. Group Differences in WISC-R Subtests and IQ Scores

WISC-R Subtest	ADHD (N=101) M (SD)	Control (N= 111) M (SD)	ADHD with Comorbidity (N= 82) M (SD)	MS	SS	F (2, 291)
Information	9.42 (2.47)	8.91a (2.49)	9.79b (2.50)	19.03	38.07	3.08*
Similarities	10.49 (2.84)	10.46 (3.85)	10.13 (3.61)	3.50	6.99	.29
Arithmetic	10.24 (2.71)	10.35 (2.71)	10.08 (3.00)	1.67	3.34	.21
Vocabulary	10.53b (2.16)	9.70a (3.25)	10.82b (2.42)	33.54	67.09	4.64*
Comprehension	10.33b (2.31)	11.20a (2.70)	10.24b (2.40)	28.67	57.35	4.63*
Digit Span	8.32b(2.62)	10.28a (3.11)	8.85b (2.61)	108.95	217.90	13.76***
Picture Completion	9.39b (2.88)	10.86a (3.00)	9.23b (2.91)	83.31	166.63	9.68***
Picture Arrangement	10.14 (3.51)	10.02 (3.03)	9.67 (2.87)	5.29	10.57	.53
Block Design	10.05b (3.00)	11.22a (3.32)	9.85b (2.91)	56.02	112.03	5.82**
Object Assembly	10.05b (2.99)	11.37a (3.18)	10.72a (2.77)	46.07	92.15	5.10**
Coding	10.70 (2.80)	10.75 (3.07)	10.73 (2.76)	.05	.11	.01
Verbal IQ	101.43 (11.54)	100.84 (13.64)	101.34 (13.83)	10.86	21.73	.06
Performance IQ	99.91b (13.87)	105.85a (14.33)	100.13b (12.74)	1177.69	2355.38	6.23**
Total IQ	100.83 (11.95)	103.59 (12.80)	100.91 (11.97)	256.82	513.64	1.70

* p < .05, ** p < .01, *** p < .001, MS: Mean Square, SS: Sum of Squares

a,b: In a line, there is a significant difference between scores that are coded with different letters. There is no difference between scores that are coded with same letters or not coded.

Table 3. Group Differences in Kaufman and Bannatyne Categories

WISC-R Category	ADHD (N=101) M (SD)	Control (N= 111) M (SD)	ADHD+ Comorbid (N= 82) M (SD)	MS	SS	F (2, 291)
Kaufman Categories						
Verbal Comprehension	10.20 (1.71)	10.07 (2.17)	10.25 (2.09)	.85	1.69	.21
Perceptual Organization	9.90b (2.14)	10.87a (2.17)	9.87b (1.97)	33.36	66.73	7.52**
Freedom From Distractibility	9.75b (1.80)	10.46a (1.89)	9.89b (1.83)	14.81	29.62	4.35*
ACID	9.67 (1.76)	10.07 (1.77)	9.86 (1.76)	4.26	8.53	1.37
Bannatyne Categories						
Spatial Abilities	9.83b (2.18)	11.15a (2.47)	9.93b (2.25)	56.59	113.19	10.59***
Sequential Abilities	9.75b (1.80)	10.46a (1.89)	9.89b (1.82)	14.81	29.62	4.35*
Acquired Knowledge	10.07 (1.98)	9.65 (2.16)	10.23 (2.04)	8.77	17.52	2.05
Conceptual Abilities	10.45 (1.79)	10.45 (2.37)	10.40 (2.27)	.09	.17	.02

* p < .05, ** p < .01, *** p < .001, MS: Mean Square, SS: Sum of Squares

a,b: In a line, there is a significant difference between scores that are coded with different letters. There is no difference between scores that are coded with same letters or not coded.

Similarly, ANOVA was conducted to compare Kaufman and Bannatyne categories of these three groups, obtained from WISC-R subtests. Table 3 shows the findings of comparisons between groups performed with the LSD method. According to the results, the control group had significantly higher scores on Kaufman's perceptual organization and freedom from distractibility patterns and Bannatyne's spatial abilities and sequential ability than the other groups (Table 3). In addition, there were no significant differences between the groups in patterns of Kaufman's verbal comprehension ability and ACID and Bannatyne's spatial abilities and sequential ability.

The predictive level of ADHD from WISC-R subtests was examined with logistic regression analysis (Table 4). The scores of 11 WISC-R subtests was included in the analysis, with the method of Backward Stepwise-Wald and in 7th step of the analysis, 5 subtest scores were observed to be significant in the model. These scores were information (Wald= 4.07, sd= 1, p= .05), vocabulary (Wald= 6.14, SD= 1, p= .05), comprehension (Wald= 5.47, SD= 1, p= .05), digit span (Wald= 16.79, SD= 1, p= .001) and picture completion (Wald= 5.25, SD= 1, p= .05).

The chi-square value for the model (48.61) was found to be significant (p <0.001). The overall rate of correct classification

Table 4. Logistic Regression Analysis Related to WISC-R Subtest Scores

Observed	Predicted		
	ADHD	Control	Percent Correct (%)
ADHD (N=101)	67	34	66.3
Control (N=111)	35	76	68.5
Total			67.5

Table 5. WISC-R Subtests Predicting ADHD

Subtests	B	OR	CI 95 %	p
Information	0.147	1.158	1.004-1.336	0.04
Vocabulary	0.179	1.196	1.038-1.379	0.01
Comprehension	-0.160	0.852	0.745-0.974	0.01
Digit Span	-0.254	0.775	0.687-0.876	<0.001
Picture Completion	-0.131	0.877	0.784-0.981	0.02

OR: Odds Ratio, CI: Confidence Interval

for the model was 67%. The predictability of the diagnostic group was 66.3%, and this value showed that 67 of 101 children with ADHD were classified correctly, while 34 were placed in the control group. According to logistic regression model, a one-unit increase in the score of information subtest raised the risk of ADHD by 15%. In addition, a one-unit increase in the score of vocabulary subtest raised the risk of ADHD by 19%. While a one-unit increase in the score of comprehension subtest decreases the risk of ADHD by 15%, this increase reduces the risk by 23% in digit span subtest and by 13% in picture completion (Table 5).

In another analyses, the predictive level of ADHD from Kaufman and Bannatyne categories was examined with logistic regression analysis (Table 6). The scores of 8 categories was included in the analysis, with the method of Backward Stepwise-Wald and in 4th step of the analysis, while 3 category scores were observed to be significant in the model. These categories were freedom from distractibility (Wald= 8.22, SD= 1, $p = 0.01$), spatial abilities (Wald= 12.22, SD = 1, $p < 0.001$), and acquired knowledge (Wald= 15.82, SD= 1, $p < 0.001$) patterns.

The chi-square value for the model (35.61) was found to be significant ($p < 0.001$). The overall rate of correct classification of the model was 62.3%. The predictability of the diagnostic group was 58.4%, and this value showed that 59 of 101 children with ADHD were classified correctly, whereas 42 were placed in the control group.

To this model, a one-unit increase in the score of spatial abilities pattern decreases the risk of ADHD by 24%. In addition, a one-unit increase in the score of freedom from distractibility pattern reduced the risk of ADHD by 28%, while each unit increase in acquired knowledge pattern increases the risk of ADHD by 50% (Table 7).

Table 6. Logistic Regression Analysis Related to Kaufman and Bannatyne Categories

Observed	Predicted		
	ADHD	Control	Percent Correct (%)
ADHD (N=101)	59	42	58.4
Control (N=111)	38	73	65.8
Total			62.3

Table 7. Kaufman and Bannatyne Categories Predicting ADHD

Categories	B	OR	CI 95 %	p
Spatial Abilities	-0.273	0.761	0.653-0.887	<0.001
Freedom From Distractibility	-0.326	0.722	0.577-0.902	<0.001
Acquired Knowledge	0.408	1.503	1.230-1.837	<0.001

OR: Odds Ratio, CI: Confidence Interval

DISCUSSION

In this study, children with ADHD were compared with the control group in terms of WISC-R IQ scores, subtest scores, and scores of Kaufman and Bannatyne categories. The results indicate that vocabulary, comprehension, digit span, picture completion, block design subtests were significantly lower for ADHD and ADHD with comorbidity groups than control group. Object assembly subtest was lower for only the ADHD group compared to the control group. On the contrary, information subtest was higher for ADHD and ADHD with comorbidity groups than the control group. Moreover, information, vocabulary, comprehension, digit span and picture completion subtests were useful predictors of ADHD.

Comprehension subtest aims at measuring individuals' capabilities of distinguishing daily life realities, adaptation to social life, appraisal of experiences, organizing information and abstract thinking (Sattler, 1998). In the literature, studies reported comprehension subtest as lower for ADHD cases than control group (Erdoğan-Bakar et al. 2011), and studies that demonstrated a different trend also drew attention (Tsai et al. 2013, Evinç & Gençöz 2007, Erdoğan-Bakar et al. 2005). Because of the social structure of its item content, this subtest represents problem solving ability related to social processes and is highly correlated with social intelligence (Campbell & McCord, 1999). Children and adolescents with ADHD have more difficulties with social compatibility and relations to their peers, parents, and teachers compared to their same age peers (Gardner & Gerdes 2013, Storebø et al. 2014, APA 2013). Reasons for such a situation are the distractibility of their attention as well as cognitive difficulties (Gardner & Gerdes 2013, Hannesdottir et al. 2014). In our study, each one-unit increase in comprehension subtest reduced the risk of ADHD risk by 15% in the logistic regression model. The

comprehension subtest scores of ADHD group was lower than the healthy group, and may suggest that children with ADHD were worse at problem solving abilities in social processes.

In this study, the digit span subtest was significantly different from healthy control group. In the logistic regression model, each one-unit increase in digit span subtest reduced the risk of ADHD risk by 23%. Studies showed that ADHD diagnosed groups had lower scores in digit span subtest than control groups (Faraone et al. 1993, Anastopoulos et al. 1994, Mayes et al. 1998, Evinç & Gençöz 2007, Erdoğan-Bakar et al. 2011). The digit-span subtest was used to evaluate the capacity of auditory short-term memory, sequential ability, and ability to focus attention. Some problems related with working memory, one of the executive function components, were reported in ADHD cases (Willcutt et al. 2005). Working memory is a limited capacity enabling the information temporarily stored and processed. It guides the behaviors and is known as the key component underlying other executive functions (Baddeley 2007). Studies emphasized that working memory capacity was lower at ADHD and this appears as short term memory difficulties in individual's test performances, and was related to inattention rather than hyperactivity and impulsivity (McInnes et al. 2003, Kofler et al. 2010, Rapport et al. 2009, Raiker et al. 2012, Gau et al. 2013).

The picture completion subtest was also statistically different. Each one-unit increase in picture completion subtest reduced the risk of ADHD by 13%. In the literature, there are studies which showed that picture completion subtest scores were different for ADHD children than controls (Erdoğan-Bakar et al. 2011), and other studies which were not (Erdoğan-Bakar et al. 2005, Zambrano-Sánchez et al. 2010, Tsai et al. 2013). Picture completion subtest was used to evaluate visual perception, attention focus, visual recognition of object's basic details, and organizing visual material (Sattler 1998). It is well documented that there might be difficulties in visual perception in ADHD (Crawford & Dewey 2008). In this study, lower scores of picture completion demonstrated that children with ADHD also might have difficulties in visually recognizing object's basic details by focusing their attention.

In this study, block design subtest was not a predictor of ADHD according to logistic regression model. However, lower scores were observed for children with ADHD in pairwise and triple comparisons. Block design subtest evaluates the ability of analyzing and integrating abstract visual stimuli, formatting non-verbalized concepts, visual perception and organization, visual-motor coordination, learning and differentiating figure-ground in visual stimuli (Sattler 1998). Many studies stated that ADHD group had lower scores for this subtest than control group (Erdoğan-Bakar et al. 2005, Evinç & Gençöz 2007, Biederman et al. 2009, Zambrano-Sánchez et al. 2010, Erdoğan-Bakar et al. 2011, Soysal et al. 2012).

Another subtest, object assembly, was not one of the predictors of ADHD in logistic regression model, but was significantly lower for ADHD groups. Object assembly subtest evaluates the ability of sensory visual motor organization, and the ability to estimate and arrange the relationship between objects (Sattler 1998). Studies on object assembly subtest showed lower scores in the ADHD groups (Zambrano-Sánchez et al. 2010), while other studies did not (Tsai et al. 2013, Evinç & Gençöz 2007). Visual spatial perception and visual configuration, which are functions of back of right hemisphere, are worse for ADHD groups than healthy controls (Durukan et al. 2008, Garcia-Sanchez et al. 1997). Moreover, 60% of ADHD cases had difficulties in visual spatial functions (Njiokiktjien & Verschoor 1998).

In this study, picture completion, block design and object assembly subtests, which are subtests of performance IQ, were different from control groups. In the study, performance IQ scores were significantly lower only for ADHD and ADHD with comorbidity groups than control group. In WISC-R, performance IQ targets to measure the abilities related to visual and spatial domains, and include tasks related attention. Therefore, the disabilities of these domains are thought to be related to ADHD (Faraone et al. 1993, Mahone et al. 2003). Zambrano-Sánchez and his colleagues (2010) found that children with ADHD had statistically lower performance and total IQ scores. On the contrary, in the study conducted with WISC-III by Tsai and his colleagues (2013), the ADHD group and control group did not differentiate between each other according to performance IQ scores. However, the ADHD group was statistically lower than control group according to verbal and total IQ scores.

For ADHD, when WISC-R IQ scores evaluated, the major tendency was that performance IQ of these children was lower than verbal IQ because of the outnumber of subtests including tasks related to attention (Faraone et al. 1993, Mahone et al. 2003, Evinç & Gençöz 2007, Öngider et al. 2008). However, some of the studies argued that WISC-R profile was not a successful measure to differentiate ADHD (Kiriş & Karakaş 2004, Erdoğan-Bakar et al. 2005, Naglieri et al. 2005, Evinç & Gençöz 2007, Erdoğan-Bakar et al. 2011).

Kaufman's perceptual organization category and Bannatyne's spatial abilities category comprise of performance subtests. In this study, although perceptual organization was not statistically significant in logistic regression model, it was significantly lower for both ADHD groups than control group. Each one-unit increase in Bannatyne's spatial ability category reduces the risk of ADHD by 24%. Of these two categories, perceptual organization includes picture arrangement and in this study, picture arrangement subtest did not differentiate between all groups. This result is consistent with the result of the study, which reported children with ADHD having difficulties in the field of spatial abilities (Mahone et al. 2003).

Kaufman's freedom from distractibility category is another category from which control group had significantly higher scores than other two groups. In our study, each one-unit increase in "freedom from distractibility" reduced the risk of ADHD by 28%. This category evaluates the functions such as short-term memory, maintaining of attention, recall of learned information, and difficulties in this category is associated with ADHD (Kaufman 1974). The studies in ADHD and normal samples showed that children with ADHD had lower scores in this category (Anastopoulos et al. 1994, Faraone et al. 1993, Mayes et al. 1998).

Besides these categories, each one-unit increase in the acquired knowledge category, which consists of information, vocabulary and arithmetic subtests, increased the risk of ADHD by 50%. In this study, information and vocabulary subtest scores of control groups was significantly lower than ADHD group. Further, each one-unit increase in information subtest increases the risk of ADHD by 15%, each one unit increase in vocabulary subtest increases the risk of ADHD by 19%.

Both subtests are sensible to many cognitive factors such as learning associated with child's life experiences and educational environment, information storage, depth of thinking, concept formation, and language development. The vocabulary subtest is a test that measures vocabulary knowledge (Sattler 1998). The clinic where the study was conducted was the first Child and Adolescent Psychiatry outpatient clinic in that city. The families that have higher socio-cultural status may apply to the clinic for their children with complaints of ADHD much more. This result may be interpreted as ADHD diagnosed children, might benefit the educational opportunities for Muş state or people from all socio-cultural groups might apply to pediatric polyclinic.

The score of sequential ability category was obtained from digit span, arithmetic, and coding subtests. In the regression model, although this pattern was not a significant prediction, there were significant differences between groups in terms of this pattern. Sequential ability was relevant with the ability to sequence visual or auditory stimulus stored in short-term memory (Karaman et al. 2006). The two subtests of this pattern (digit span and coding) are the same as subtests in freedom from distractibility factor that Kaufman manifested. In the next revisions of WISC-R, these two subtests were evaluated in different categories (digit span within working memory and coding within processing speed) and some researches revealed that children with ADHD had lower scores in both areas (Calhoun & Mayes 2005; Mayes & Calhoun 2006). Karaman et al. (2006). In their study, they compared children with SLD with children with both SLD and ADHD, and reported that Bannatyne's sequential ability score was lower in the group of children with both SLD and ADHD.

In this study, there were no statistically significant differences between groups in terms of ACID pattern. Prifitera and Dersh (1993) compared children with SLD and ADHD with WISC-III standardization sample and found that score of ACID pattern was the lowest in ADHD group. They also reported that the ACID and Bannatyne patterns contributed to distinguish clinical samples from normal samples but had limited use in differentiating ADHD diagnosis (Prifitera & Dersh 1993). In the other studies, arithmetic, coding, information and digit span subtests were within the subtests having the lowest scores in samples with both ADHD and ADHD with comorbid SLD but that there wasn't statistically significant difference between two groups (Albers 1998, Schwan & Saklofske 2005). In our study, the reason why there was no significant difference in ACID pattern may be associated with groups that have different scores on information subtest.

Consequently, the findings of the present study showed that children with ADHD had neurocognitive problems. Although different results were obtained in terms of subtests and patterns, WISC-R is thought to be a good tool for understanding of neurocognitive features of children with ADHD. WISC-R subtests can provide with information about cognitive functions. Especially, comprehension, digit span, and picture completion subtests and spatial abilities and freedom from distractibility patterns were predictors of ADHD in this study. The findings revealed that WISC-R provided useful information to understand ADHD. In addition, the scale might help to find out cognitive strengths and weaknesses of children with ADHD and to develop treatment plans for them. WISC-IV (Wechsler 2003, Uluç et al. 2011), whose Turkish standardization study has completed and will be in use soon, provides four-factor structure and freedom from distractibility and spatial abilities are within different factors. Given this four-factor structure may be more functional in understanding ADHD in Turkey, evaluating the ADHD children's cognitive structures as well as the pattern and predictive values still needs to be investigated.

Limitations

The tests used in the study are tests which standardization, reliability and validity studies in Turkish sample were conducted. One of limitations of the present study is that the findings were not examined in terms of subtypes in children with ADHD. Another limitation is that cognitive processes investigated were not supported by the other neuropsychological tests.

In this study, scores of information and vocabulary subtests were higher in ADHD group. Similarly, it was observed that in the regression model, high scores of acquired knowledge pattern predicted to have ADHD. These findings may be interpreted as supporting the notion that children who referred to Child and Adolescent Psychiatry Polyclinic for attention

deficit complaints and diagnosed with ADHD may be benefit from education opportunities and patients from all socio-cultural groups may be coming to pediatric polyclinic, which formed the control group. In this sense, socio-cultural and socio-economical levels of the groups were not evaluated.

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REFERENCES

- Albers NC (1998) Use of the Wechsler Intelligence Scale for Children-Third Edition and the Wechsler Individual Achievement Test in the diagnosis of learning in an attention deficit disorder referred population. *Dissertation Abstracts International: Section B: The Sciences and Engineering* 58(7-B), 3913.
- American Academy of Child and Adolescent Psychiatry (2007) Practice parameter for the assessment and treatment of children and adolescents with attention-deficit/hyperactivity disorder. *J Am Acad Child Adolesc Psychiatry* 46: 894-921.
- Amerikan Psikiyatri Birliği (2013) Diagnostic and statistical manual of mental disorders. Fifth Edition. (DSM-5) Arlington, VA, p. 59-66.
- Anastopoulos AD, Spisto MA, Maher MC (1994) The WISC-III freedom from distractibility factor: Its utility in identifying children with attention deficit hyperactivity disorder. *Psychological Assessment* 6: 368-71.
- Baddeley A (2007) Working memory, thought, and action. New York: Oxford University Press.
- Bannatyne A (1974) Diagnosis: A note on recategorization of the WISC scaled scores. *J Learning Disabilities* 7: 272-3.
- Biederman J, Petty CR, Ball SW et al (2009) Are cognitive deficits in attention deficit/ hyperactivity disorder related to the course of the disorder? A prospective controlled follow-up study of grown up boys with persistent and remitting course. *Psychiatry Res* 30;170:177-82.
- Campbell JM, McCord DM (1999) Measuring social competence with the Wechsler picture arrangement and comprehension subtests. *Assessment* 6: 215-23.
- Calhoun SL, Mayes SD (2005) Processing speed in children with clinical disorders. *Psychol Sch* 42: 333-43.
- Crawford SG, Dewey D (2008) Co-occurring disorders: a possible key to visual perceptual deficits in children with developmental coordination disorder? *Hum Mov Sci* 27:154-69.
- Devena SE, Watkins MW (2012) Diagnostic utility of WISC-IV general abilities index and cognitive proficiency index difference scores among children with ADHD. *Journal of Applied School Psychology*, 28: 133-54.
- Durukan I, Türkbay T, Cöngöloğlu A (2008) The effects of methylphenidate on various components of visual attention in children with attention-deficit hyperactivity disorder. *Türk Psikiyatri Derg* 19:358-64.
- Ercan ES, Amado S, Somer O et al (2001) Dikkat eksikliği hiperaktivite bozukluğu ve yıkıcı davranım bozuklukları için bir test bataryası geliştirme çabası. *Çocuk ve Gençlik Ruh Sağlığı Dergisi* 8: 132-44.
- Erdoğan-Bakar E, Soysal AŞ, Kiriş N et al (2005) Dikkat eksikliği hiperaktivite bozukluğunun değerlendirilmesinde Wechsler Çocuklar için Zekâ Ölçeği geliştirilmiş formunun yeri. *Klinik Psikiyatri* 8: 5-17.
- Erdoğan-Bakar E, Soysal AŞ, Kiriş N et al (2011) Wechsler Çocuklar için Zekâ Ölçeği yeniden gözden geçirilmiş formunun dikkat eksikliği hiperaktivite bozukluğunda ölçtüğü özellikler. *Çocuk ve Gençlik Ruh Sağlığı Dergisi* 18: 155-74.
- Evinç GŞ, Gençöz T (2007) Dikkat Eksikliği Hiperaktivite Bozukluğu tanısı alan çocukların WISC-R profillerinin, farklı bir psikiyatrik tanı alan ve herhangi bir tanısı olmayan çocuklarla karşılaştırılması. *Türk Psikiyatri Derg* 18: 109-17.
- Faraone SV, Biederman J, Krifcher B et al (1993) Intellectual performance and school failure in children with attention deficit hyperactivity disorder and their siblings. *J Abnorm Psychol* 102: 616-23.
- Garcia-Sanchez C, Estevez-Gonzalez A, Suarez-Romero E et al (1997) Right hemisphere dysfunction in subjects with attention-deficit disorder with and without hyperactivity. *J Child Neurol* 12:107-15
- Gardner DM, Gerdes AC (2013) A review of peer relationships and friendships in youth with ADHD. *J Atten Disord* Sep 23. [Epub ahead of print]
- Gau SS, Chiu CD, Shang CY et al (2009). Executive functions in adolescence among children with attention-deficit/hyperactivity disorder. *J Dev Behav Pediatr* 30: 525-34.
- Hannesdottir DK, Ingvarsdottir E, Bjornsson A (2014) The OutSMARTers program for children with ADHD: A pilot study on the effects of social skills, self-regulation, and executive function training. *J Atten Disord* Feb 6 [Epub ahead of print]
- Karaman D, Türkbay T, Gökçe FS (2006) Özgül öğrenme bozukluğu ve dikkat eksikliği hiperaktivite bozukluğu binişliğinin bilişsel özellikleri. *Çocuk ve Gençlik Ruh Sağlığı Dergisi* 13: 60-8.
- Kaufman AS (1979) Intelligence Testing with The WISC-R, New York, John Wiley and Sons s. 12.
- Kaufman AS (1975) Factor analysis of the WISC-R at age levels between 6,5 and 16,5. *J Consult Clin Psychol* 43: 135-47.
- Kaufman NL, Kaufman AS (1974) Comparison of normal and minimally brain dysfunctions children on the McCarthy Scales of Children's Abilities. *J Clin Psychol* 30:69-72.
- Kiriş N, Karakaş S (2004) Dikkat eksikliği hiperaktivite bozukluğunun zekâ testlerinden ve ilgili diğer nöropsikolojik araçlardan yordanabilirliği. *Klinik Psikiyatri Dergisi* 7:139-52.
- Kofler MJ, Rapport MD, Bolden J et al (2010) ADHD and working memory: the impact of central executive deficits and exceeding storage/rehearsal capacity on observed inattentive behavior. *J Abnorm Child Psychol* 38:149-61.
- Korzeniowski CG (2011) Developmental evolution of executive functioning and its relationship with academic learning. *Revista de Psicología* 7: 7-26.
- Lange KW, Hauser J, Lange KM et al (2014) Utility of cognitive neuropsychological assessment in attention-deficit/hyperactivity disorder. *Atten Defic Hyperact Disord* Mar 18. [Epub ahead of print]
- Lufi D, Cohen A (1985) Using the WISC-R to identify attention deficit hyperactivity disorder. *Psychol Sch* 22: 58.
- Mahone EM, Miller TL, Koth CW et al (2003) Differences between WISC-R and WISC-III performance scale among children with ADHD. *Psychol School* 40: 331-40.
- Mayes SD, Calhoun SL, Crowell EW (1998) WISC-III Freedom From Distractibility as a measure of attention in children with and without attention deficit hyperactivity disorder. *J Atten Disord* 2: 217-27.
- Mayes SD, Calhoun SL (2006) WISC-IV and WISC-III profiles in children with ADHD. *J Atten Disord* 9: 486-93.
- McInnes A, Humphries T, Hogg-Johnson S et al (2003). Listening comprehension and working memory are impaired in attention-deficit hyperactivity disorder irrespective of language impairment. *J Abnorm Child Psychol* 31: 427-43.
- Naglieri JA, Goldstein S, Delauder BY et al (2005) Relationships between the WISC-III and the cognitive assessment system with Conners' rating scales and continuous performance tests. *Arch Clin Neuropsychol* 20: 385-401.
- Njokiktjen CH, Verschoor CA (1998) Attention deficits in children with low performance IQ: arguments for right hemisphere dysfunction. *Fiziol Cheloveka* 24:16-22.
- Öngider N, Baykara B, Pekcanlar-Akay A (2008) Bir çocuk psikiyatrisi polikliniğinde ayaktan izlenen olgulardan DEHB ve/veya ÖÖB tanısı konan çocukların WISC-R testi sonuçlarının karşılaştırılması. *New/Yeni Symposium Journal* 46: 17-22.
- Priftera A, Dersh J (1993) Base rates of WISC-III diagnostic subtest patterns among normal, learning-disabled, and ADHD samples. *Wechsler*

- Intelligence Scale for Children (3rd ed.). Journal of Psychoeducational Assessment. Advances in psycho educational assessment. Bracken BA, McCallum RS (Eds) Brandon, VT, US: Clinical Psychology Publishing Co pp. 43-55.
- Raiker JS, Rapport MD, Kofler MJ et al (2012) Objectively-measured impulsivity and attention-deficit/hyperactivity disorder (ADHD): Testing competing predictions from the working memory and behavioral inhibition models of ADHD. *J Abnorm Child Psychol* 40: 699–713.
- Rapport MD, Bolden J, Kofler MJ et al (2009) Hyperactivity in boys with attention-deficit/hyperactivity disorder (ADHD): a ubiquitous core symptom or manifestation of working memory deficits? *J Abnorm Child Psychol* 37:521-34.
- Rossi AF, Pessoa L, Desimone R et al (2009) The prefrontal cortex and the executive control of attention. *Exp Brain Res* 192:489-97.
- Rubia K, Smith AB, Halari R et al (2009) Disorder-specific dissociation of orbitofrontal dysfunction in boys with pure conduct disorder during reward and ventrolateral prefrontal dysfunction in boys with pure ADHD during sustained attention. *Am J Psychiatry* 166:83-94.
- Tsai CS, Huang YS, Wu CL et al (2013) Long-term effects of stimulants on neurocognitive performance of Taiwanese children with attention-deficit/hyperactivity disorder. *BMC Psychiatry* 4;13:330.
- Turgay A (1995) Çocuk ve ergenlerde davranım bozuklukları için DSM-IV'e dayalı tarama ve değerlendirme ölçeği (Yayınlanmamış ölçek). Integrative Therapy Institute Toronto, Kanada.
- Sattler JM (2002) Assessment of children. Behavioral and clinical implications (4th ed.). San Diego: Jerome M. Sattler, Publisher, Inc.
- Sattler JM (1998) Assessment of children, revised and updated third dition. San Diego: Jerome M. Sattler, Publisher, Inc.
- Savaşır I, Şahin N (1995) Wechsler Çocuklar İçin Zeka Ölçeği (WÇZÖ-R) El Kitabı. Türk Psikologlar Derneği Yayınları, Ankara.
- Schwean VL, Saklofske DH (2005) Assessment of attention-deficit/hyperactivity disorder with the WISC-IV. WISC-IV clinical use and interpretation. A Prifitera, DH Saklofske, LG Weiss (Eds.) San Diego, CA: Academic Press pp. 235–80.
- Seidman LJ, Biederman J, Faraone SV et al (1997) A pilot study of neuropsychological function in girls with ADHD. *J Am Acad Child Adolesc Psychiatry* 36: 366-73.
- Siu AF, Zhou Y (2014) Behavioral assessment of the dysexecutive syndrome for children: An examination of clinical utility for children with attention-deficit hyperactivity disorder (ADHD). *J Child Neurol* Jan 21. [Epub ahead of print]
- Smith CB, Watkins MW (2004) Diagnostic utility of the Bannatyne WISC-III pattern. *Learn Disabil Res Pract* 19: 49-56.
- Snow JB, Sapp GL (2000) WISC-III subtest patterns of ADHD and normal samples. *Psychol Rep* 87: 759–65.
- Spencer TJ, Biederman J, Mick E (2007) Attention-deficit/hyperactivity disorder: diagnosis, lifespan, comorbidities, and neurobiology. *J Pediatr Psychol* 32:631-42.
- Storebø OJ, Skoog M, Darling Rasmussen P et al (2014) Attachment competences in children with ADHD during the social-skills training and attachment (SOSTRA) randomized clinical trial. *J Atten Disord*. Feb 14. [Epub ahead of print]
- Soyşal Ş, Tan S, Aldemir S (2012). Accuracy of WISC-R and Raven Standard Progressive Matrices Tests in mathematical success of children with ADHD. *Düşünen Adam Psikiyatri ve Nörolojik Bilimler Dergisi* 25: 17-26.
- Uluç S, Öktem F, Erden G et al (2011) Wechsler Çocuklar için Zekâ Ölçeği-IV: Klinik bağlamda zekânın değerlendirilmesinde Türkiye için yeni bir dönem. *Türk Psikoloji Yazıları* 14, 49-57.
- Wechsler D (2003) WISC-IV technical and interpretive manual. San Antonio, TX: Psychological Corporation.
- Wechsler D (1991) Manual for the Wechsler Intelligence Scale for Children (3rd ed.). New York: Psychological Corp.
- Wechsler D (1974) Manual for the Wechsler Intelligence Scale for Children- Revised. New York: Psychological Corp.
- Willcutt EG, Doyle AE, Nigg JT et al (2005) Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biol Psychiatry* 57: 1336–46.
- Zambrano-Sánchez E, Martínez-Cortés JA, Rió-Carlos YD et al (2010) Executive dysfunction screening and intellectual coefficient measurement in children with attention deficit hyperactivity disorder. *Arq Neuropsiquiatr* 68:545-9.