Düşünen Adam The Journal of Psychiatry and Neurological Sciences 2012;25:17-26
DOI: 10.5350/DAJPN2012250102



# Accuracy of WISC-R and Raven Standard Progressive Matrices Tests in Mathematical Success of Children with ADHD

Şebnem Soysal[1], Seda Tan[2], Seçil Aldemir[3]

[1]Psychologist, Ph.D., Gazi University Medical School, Department of Pediatrics, Ankara - Turkey
[2]Psychologist, Fatih University Medical School, Department of Psychiatry, Ankara - Turkey
[3]Psychiatrist, Fatih University Medical School, Department of Psychiatry, Ankara - Turkey

**ABSTRACT**

Accuracy of WISC-R and Raven Standard Progressive Matrices Tests in mathematical success of children with ADHD

This study investigated whether Wechsler Intelligence Scale for Children – Revised Form (WISC-R) and Raven Standard Progressive Matrices (RSPM) tests can accurately predict the mathematical success of children in elementary school with Attention Deficit Hyperactivity Disorder (ADHD).

**Method:** In this study, WISC-R and RSPM tests were performed on 150 elementary school children (25 attention deficit, 25 hyperactivity-impulsivity, 25 combined type, 75 Control) aged 6 to 10 years. In the evaluation process, children's attitude toward mathematics was determined and their scores were recorded.

**Results:** Children in the control group scored higher in WISC-R subtests. Also there were significant differences in some WISC-R subtests (Vacobulary, Picture Arrangement, Picture Arrangement and Coding) scores between ADHD subtypes. When the relationship between WISC-R and RSPM tests was examined using Spearman's rank correlation coefficient, a weak but significant positive correlation was found.

**Conclusion:** This study showed that WISC-R and RSPM tests did not predict mathematical success. Also it showed that there was no linear correlation between mathematical skills and cognitive activity speed of studied elementary school children with ADHD.

**Key words:** WISC-R, attention deficit hyperactivity disorder, mathematics

**ÖZET**

WISC-R ve Raven Standart Progresif Matrisler Testinin DEHB tanısı alan çocuklarda matematik başarısını belirleme gücü

Bu araştırmada, Wechsler Çocuklar İçin Zeka Ölçeği (WISC-R) ve Raven Standart Progresif Matrisler (RSPM) testlerinin Dikkat Eksikliği Hiperaktivite Bozukluğu (DEHB) tanılı ilköğretim öğrencilerinin matematik başarısını ne kadar yordadığı incelenmiştir.

**Yöntem:** Araştırmada, yaşları 6-10 arasında değişen 150 erkek ilköğretim öğrencisine (25 DEHB-DE, 25 DEHB-HD, 25 DEHB-B, 75 Sağlıklı) WISC-R ve RSMP uygulanmıştır. Uygulamada çocukların matematik dersine karşı olan tutumları belirlenmiş ve ders notları kaydedilmiştir.

**Bulgular:** WISC-R alttestlerinden, kontrol grubunda yer alan çocukların daha yüksek puanlar aldıkları belirlenmiştir. DEHB alttipleri arasında ise, bazı WISC-R alttest (kelime dağarcığı, resim düzenleme ve şifre) puanlarında anlamlı farklılıklar bulunmuştur. WISC-R ile RSPM arasındaki ilişkiler, Spearman sıra korelasyon katsayısı ile incelenmiş, matematik notu ile RSPM toplam puan arasında zayıf ancak pozitif yönde anlamlı bir ilişki olduğu belirlenmiştir.

**Sonuç:** Çalışmada, WISC-R ile RSPM'nin matematik başarısını yordamadığı belirlenmiştir. DEHB tanısıyla izlenen ilköğretim öğrencilerinin matematiksel işlem becerileri ile bilişsel faaliyet hızları arasında doğrusal bir ilişkinin olmadığı ortaya konmuştur.

**Anahtar kelimeler:** WISC-R, Dikkat eksikliği hiperaktivite bozukluğu, matematik

Address reprint requests to:
Psychologist Seda Tan, Fatih University Medical School, Department of Psychiatry Alparslan Türkeş Cad. No: 57 06510 Emek, Ankara - Turkey

Phone: +90-312-203-5555/5732

Fax: +90-312-203-5028

E-mail address:
psksedа@gmail.com

Date of receipt:
February 03, 2011

Date of acceptance:
July 25, 2011

## INTRODUCTION

Intelligence is a comprehensive natural faculty which provides the person to perceive his/her environment and to cope with it (1). Neuropsychological studies on intelligence indicate several cognitive functions. Intelligence tests indicate that these functions work together and make up a single experience. For this reason, intelligence tests are frequently applied to gather information about cognitive functions (2).

Currently, Wechsler Intelligence Scale for Children – Revised Form (WISC-R) is among the foremost tests to

differentiate clinical groups and determine specific competences in Turkey (3,4). WISC-R has frequently been preferred to differentiate various clinical groups mainly due to its known assessment spectrum and factorial structure (5-7). Studies about determining WISC-R profiles among various clinical groups and their relationships between different variables increased in the last 30 years (8-13). The ultimate progress today has been achieved at specific learning difficulty (SLD). There are unexpected differences between verbal and performance intelligence sections of WISC-R test scores in children with SLD in the literature (14). Similarly, it was reported that these children achieved quite lower scores from verbal intelligence section. After factorial analysis performed due to this evident score difference between verbal and performance intelligence sections, obtained Banattayne categories make up an important extreme to differentiate learning difficulty. Four categories which were formed from different components of WISC-R sub-tests were calculated by Banattayne (9,15), Rugel and Rosenthal (16). These categories consist of visual-spatial ability which assesses ability of manipulating objects on a multi-dimensional space without any sequence (picture completion + block design); verbal conceptualization abilities which assess utilization of linguistic functions, concept and abstract thinking (reasoning + similarities + vocabulary); sequencing ability which tests recalling the sequence of visual and auditory impulses retrieved at short-term memory (digit span + picture concepts + coding) and information processing; obtained information which assesses ability to utilize obtained information to solve problems encountered in social life (general knowledge + arithmetic + vocabulary) (17,18). Achieving a score under 30 is accepted as an important clue for specific learning difficulty. It was observed that arithmetic, digit span and coding sub-tests have differential properties for other psychopathologies. However, lack of specificity of these tests to a single psychopathology lead to thorough investigation of the structure of this test (19,20). At this point, WISC-R becomes a test to control confounding variables coming from intelligence.

The most frequent psychopathologies seen at primary education period are attention deficit and hyperactivity disorder (ADHD) and SLD (21,22). These disorders are clinical diagnoses and are not based on a phenomenological basis. Lack of any laboratory finding or a specific diagnostic test for an exact diagnosis is one of the most important problems encountered to enlighten the etiologies of these disorders. Thus, tests become more important to describe clinical features of ADHD and SLD. More evident roles of tests or test combinations in differential diagnosis are getting more important for neuropsychiatry practice. Moreover, mathematics performance is low at both psychopathologies (23-26). There is not an achievement test for assessment of mathematics performance in Turkey. Arithmetic sub-test within WISC-R consists of 18 questions from simple to harder that requires simple arithmetic operations and mental arithmetic. First 15 problems are read to the child. Last 3 questions are shown in written format and child is required to read them loudly. Child is required to answer in a limited time without using pen and paper. Test is terminated after four consecutive failures. This sub-test is accepted to assess basic arithmetic knowledge, reasoning skills on abstract numeric concepts, verbal memory utilization and attention focusing and relieving from distractions (5). This sub-test is inadequate due to not allowing pen and paper and relying only on basic operation knowledge. At this point, an alternative test to assess mathematics skills is considered as Raven Standard Progressive Matrices (RSPM) test.

RSPM is a multiple choice test assessing reasoning and abstraction characteristics of intelligence non-verbally. RSPM assesses analytical investigation, problem solving, regular thinking, abstraction and mental process speed. Due to these characteristics, this test is classified as a general aptitude test in the literature. Test not only assesses general aptitude but visual-spatial functions, reasoning, mental flexibility, abstract reasoning and analytical thinking (i.e., fluent intelligence) as well (4,27). Several studies mentioned that RSPM is the most suitable assessment tool for analytical intelligence (28,29). Test also assesses general aptitude called as g factor and visual-spatial skills called as k factor (30-34). In a study which evaluates predictive value of RSPM at future mathematics success of normal and high-normal students (35), Raven test which

assesses mental potential was administered to grade two primary school students attending to a school with conventional curricula. Mathematics Achievement Test was administered to the same students at fifth grade and correlation between scores of this test and Raven test at second grade was compared and predictive value at Mathematics Achievement Test of RSPM between high-normals and normals.

In this study, we aimed to investigate the predictive power of WISC-R and RSPM at mathematical achievement in children with attention deficit and hyperactivity disorder.

## METHODS

### Participants

ADHD is a disorder seen 1/2 to 1/10 times more in boys than girls albeit its exact cause has not been found yet (36). In Turkey, gender distribution was reported to be 6 times higher in boys (37,38). For this reason, we decided to conduct this study at boys. Study was first conducted in 25 boys (16.7%) with attention deficit and 25 boys (16.7%) with hyperactivity/impulsivity and 25 boys (16.7%) with combined type who were admitted to Child Neurology and Child Psychiatry outpatient clinics of Gazi University with attention problems and excessive motor activity and with 75 healthy boys (50%) and their mothers for control group. Healthy control group was selected from children attending various primary schools at Ankara who have no psychiatric and neurological disorder matched with age and grade characteristics of the diagnosis group.

Participants were evaluated according to DSM-IV-TR diagnostic criteria. Afterwards, all criteria collected under main topic of "Attention Deficit and Destructive Conduct Disorders" according to DSM-IV were interviewed with participants and their parents. Participants from each group who could not maintain at least 6 items for at least 6 months were determined according to diagnostic criteria for attention deficit-dominant type (ADHD-AD), hyperactivity and impulsivity-dominant type (ADHD-HD) and combined type (ADHD-C). Conners' Parent Rating Scale (CPRS) was administered to mothers and Conners' Teacher Rating Scale (CTRS) was administered to teachers for rating ADHD as well. Evaluated participants were also examined for clinical conditions other than ADHD. Participants with ADHD who have no concomitant disease were included in the study.

### Data Collection Tools

**Information Collection Form:** This form was created by investigators in order to record socio-demographic data of participants.

**Wechsler Intelligence Scale for Children – Revised Form:** Wechsler Intelligence Scale for Children which was used to determine intelligence levels of children participated in the study was developed by Wechsler in 1949 and revised form (WISC-R; Wechsler Intelligence Scale for Children-Revised) was developed in 1974. WISC-R consists of two sections which are verbal and performance sections. Standardization WISC-R in Turkish children was done by Savaşır and Şahin (39) in a sample of 1639 children between 6 and 16 years old. Two half test reliability was 0.97 for verbal, 0.93 for performance sections and 0.97 for total. Correlation between sub-tests varied between 0.51 and 0.86.

**Wechsler Intelligence Scale for Children – Arithmetic Sub-test:** It consists of 18 items from simple to difficult and requiring simple arithmetic operations and to be solved from memory. First 15 problems are read to the child. Last 3 items are shown in written format and child is required to read them loudly. Each problem is expected to be answered without pen and paper in a limited time. Test is interrupted after four consecutive failures. This sub-test is accepted to assess basic arithmetic knowledge, reasoning skills on abstract numerical concepts, utilization of verbal memory, concentrating attention and avoiding distraction skills (5).

**Raven Standard Progressive Matrices Test (RSPM):** This test which is widely used to assess general aptitude and visual-spatial perception was

developed by Raven and Court (40). Standardization study of RSPM for Turkish children between 6 and 15 years old was done by Şahin and Düzen (41). A sample consisting of 2277 Turkish children between 6 and 15 years old was selected, norm values of the test were determined and statistical and psychometric properties of the test was established. Two half reliability of the test was found 0.91 for the whole sample. Correlation between sub-tests varied between 0.58 and 0.95.

### Process

At the first step of determining ADHD patients, all participants who were referred to child psychiatry outpatient clinics with attention deficit and hyperactivity complaints were evaluated according to DSM-IV-TR diagnostic criteria. All criteria covered under main topic of "Attention Deficit and Destructive Conduct Disorders" according to DSM-IV were asked to participants and their mothers at this interview. For ADHD – AD, ADHD – HD and ADHD – C sub-types according to diagnostic criteria, participants who maintained at least 6 items from each group throughout at least 6 months with incompatibility with the developmental level were determined. CPRS was administered to parents and CTRS to teachers for rating of ADHD as well. Participants included in the assessment were examined for clinical conditions other than ADHD as well. Participants with ADHD who have not any other concomitant disease were determined.

Control group was formed from children attending to various primary schools of Ankara and having no neurological, psychiatric or pediatric disease. Conners scales were administered to families and teachers at the control group and also all criteria covered under main topic of "Attention Deficit and Destructive Conduct Disorders" according to DSM-IV were interviewed with children and their parents. Participants who were not found ADHD signs were included into control group

Information collection form in which socio-demographic characteristics were recorded were filled and mathematics lesson grades were learned at interviews done with families. Tests were administered by specialized psychologists in two sessions at morning hours. Administration of both tests continues for 1 hour. Participants were first administered WISC-R and RSPM was administered after an hour break.

Informed consent about the study was taken from children participated and their families. Teachers of children selected were first interviewed and information about the study was given. According to feedback of the teacher, families who were thought to volunteer and meet the study criteria were contacted. At the interviews done with children in control group, families of the children whom a psychopathology was detected were informed and referred to relevant clinics.

### Statistical Analysis

WISC-R and RSPM scores obtained from children of the study group were transferred to computer and error checks and corrections were done separately. Consistency to normal distribution of all of the scale, scores of sub-scores and total scores were examined both graphically and by Shapiro-Wilk test. It was observed that whole data were not consistent with normal distribution. Descriptive statistics were shown by median values (Inter-quartile Range – IQR). Kruskal-Wallis non-parametric analysis of variance was performed for inter-group comparisons. When a difference was found after variance analysis, Bonferroni corrected Mann-Whitney U test was used for post-hoc dual comparisons in order to determine the origin group/groups of difference. Differences between children with ADHD and healthy children were examined by Mann-Whitney test. Spearman sequential correlation coefficient was calculated to investigate the correlation between Wechsler and Raven scales. SPSS for Windows Version 15.0 (SPSS Inc., Chicago, IL., USA) and MS-Excel 2003 software packages were used for all statistical analyses and calculations. $p<0.05$ was taken as level of significance for statistical decisions.

## RESULTS

Study was conducted with 150 children whom were between 72 and 131 months old (median=104.5;

IQR=29.0). Ages of children were similar between study groups ($\chi^2$=0.678; p=0.878). Among ADHD sub-types, 25 children were recruited at each group and 75 healthy controls were included in the study.

Mathematics grades and median and inter-quartile deviation (IQR) values of WISC-R sub-tests and RSPM of all participants were given in Table 1. When Table 1 is examined, it can be seen that mathematics grades were statistically significantly different between study groups ($\chi^2$=38.483; p<0.001). When main reason of this difference was further analyzed, while a significant difference was found between attention deficit and control (p<0.001) and hyperactivity and control groups (p<0.001), no statistically significant difference was found between other groups (p>0.05).

When WISC-R sub-tests were examined, significant differences were found between groups. Differences between groups were detected at all sub-tests of verbal intelligence section except similarities. In General Knowledge sub-test, statistically significant differences were also found between groups ($\chi^2$=29.931; p<0.001). When the origin of differences was examined, while significant difference (p<0.001) was found between attention deficit and control groups, differences between other groups were not found to be statistically significant (p>0.05). Statistically significant difference was found between groups in arithmetic sub-test ($\chi^2$=12.811; p=0.005). When the origin of difference was examined, significant difference (p<0.001) was found between attention deficit and control groups but differences between other groups were not statistically significant (p>0.05). In Vocabulary sub-test, statistically significant difference was found between groups ($\chi^2$=17.985; p<0.001). When the origin of difference was examined, significant difference was found between attention deficit and hyperactivity and attention deficit (p=0.005) and between attention deficit and control groups (p<0.001) but differences between other groups were not found statistically significant (p>0.05). In reasoning sub-test, statistical difference was found between groups ($\chi^2$=8.496; p=0.037). When the origin of difference was examined,

**Table 1: Median and Inter-Quartile Range (IQR) Values about Mathematics Grades, WISC-R Sub-tests and RSPM**

| Variables | Attention Deficit | | Hyperactivity | | Combined type | | Control | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | Median | IQR | Median | IQR | $\chi^2$ | p |
| Mathematics grade | 3.00 | 1.00 | 4.00 | 1.50 | 5.00 | 2.00 | 5.00 | 1.00 | 38.483 | <0.001 |
| General knowledge | 8.00 | 1.50 | 10.00 | 4.00 | 10.00 | 3.00 | 10.00 | 2.00 | 29.931 | <0.001 |
| Similarities | 11.00 | 3.00 | 13.00 | 3.50 | 11.00 | 3.50 | 12.00 | 1.00 | 5.593 | 0.133 |
| Arithmetic | 9.00 | 1.50 | 11.00 | 2.50 | 9.00 | 2.50 | 10.00 | 2.00 | 12.811 | 0.005 |
| Vocabulary | 10.00 | 1.00 | 10.00 | 2.00 | 10.00 | 3.00 | 11.00 | 2.00 | 17.985 | <0.001 |
| Judgement | 10.00 | 1.00 | 11.00 | 2.50 | 11.00 | 2.00 | 11.00 | 2.00 | 8.496 | 0.037 |
| Digit span | 9.00 | 2.00 | 10.00 | 4.00 | 9.00 | 4.50 | 10.00 | 2.00 | 12.509 | 0.006 |
| Picture completion | 10.00 | 2.50 | 11.00 | 3.50 | 10.00 | 4.50 | 11.00 | 2.00 | 6.264 | 0.099 |
| Picture concepts | 9.00 | 2.00 | 10.00 | 2.00 | 9.00 | 2.50 | 10.00 | 2.00 | 17.063 | <0.001 |
| Block design | 10.00 | 3.00 | 10.00 | 3.00 | 10.00 | 6.50 | 11.00 | 2.00 | 5.608 | 0.132 |
| Matrix reasoning | 10.00 | 2.50 | 10.00 | 1.50 | 10.00 | 3.00 | 10.00 | 1.00 | 1.761 | 0.623 |
| Coding | 10.00 | 2.00 | 12.00 | 4.50 | 11.00 | 2.00 | 11.00 | 2.00 | 13.655 | 0.003 |
| Labyrinths | 10.00 | 1.50 | 10.00 | 3.00 | 10.00 | 2.00 | 11.00 | 2.00 | 5.631 | 0.131 |
| Verbal intelligence section | 98.00 | 8.00 | 106.00 | 14.50 | 97.00 | 16.00 | 107.00 | 8.00 | 23.694 | <0.001 |
| Performance intelligence section | 96.00 | 14.50 | 105.00 | 12.50 | 101.00 | 18.00 | 104.00 | 9.00 | 10.843 | 0.013 |
| Total intelligence section | 98.00 | 10.00 | 107.00 | 14.50 | 101.00 | 17.50 | 106.00 | 9.00 | 20.836 | <0.001 |
| RSPMa | 9.00 | 2.50 | 9.00 | 3.00 | 9.00 | 3.00 | 10.00 | 3.00 | 8.462 | 0.037 |
| RSPMb | 6.00 | 5.50 | 6.00 | 5.50 | 5.00 | 4.50 | 9.00 | 5.00 | 14.671 | 0.002 |
| RSPMc | 3.00 | 4.50 | 5.00 | 4.00 | 3.00 | 2.00 | 7.00 | 4.00 | 24.801 | <0.001 |
| RSPMd | 3.00 | 4.00 | 3.00 | 5.50 | 2.00 | 4.00 | 6.00 | 5.00 | 23.958 | <0.001 |
| RSPMe | 1.00 | 2.00 | 1.00 | 2.00 | 1.00 | 2.50 | 2.00 | 4.00 | 15.811 | <0.001 |
| RSPM total score | 22.00 | 12.00 | 22.00 | 13.00 | 22.00 | 12.50 | 34.00 | 17.00 | 26.859 | <0.001 |
| RSPM duration (minutes) | 35.00 | 18.00 | 37.00 | 16.00 | 31.00 | 8.00 | 36.00 | 21.00 | 4.568 | 0.206 |

RRSPM: Raven Standard Progressive Matrices Test, WISC-R: Wechsler Intelligence Scale for Children, $\chi^2$: Chi-square Test

**Table 2: Median and Inter-Quartile Range (IQR) Values about Mathematics Grades, WISC-R Sub-tests and RSPM in ADHD and control groups**

| Variables | ADHD | | Control | | | |
|---|---|---|---|---|---|---|
| | Median | IQR | Median | IQR | Z | p |
| Mathematics grade | 4.00 | 2.00 | 5.00 | 1.00 | 5.479 | <0.001 |
| General knowledge | 9.00 | 3.00 | 10.00 | 2.00 | 4.611 | <0.001 |
| Similarities | 12.00 | 4.00 | 12.00 | 1.00 | 0.335 | 0.737 |
| Arithmetic | 9.00 | 3.00 | 10.00 | 2.00 | 2.334 | 0.020 |
| Vocabulary | 10.00 | 2.00 | 11.00 | 2.00 | 3.052 | 0.002 |
| Judgement | 11.00 | 2.00 | 11.00 | 2.00 | 1.668 | 0.095 |
| Digit span | 9.00 | 3.00 | 10.00 | 2.00 | 3.388 | <0.001 |
| Picture completion | 10.00 | 3.00 | 11.00 | 2.00 | 0.863 | 0.388 |
| Picture concepts | 9.00 | 3.00 | 10.00 | 2.00 | 2.770 | 0.006 |
| Block design | 10.00 | 3.00 | 11.00 | 2.00 | 2.109 | 0.035 |
| Matrix reasoning | 10.00 | 3.00 | 10.00 | 1.00 | 1.011 | 0.312 |
| Coding | 11.00 | 4.00 | 11.00 | 2.00 | 0.688 | 0.491 |
| Labyrinths | 10.00 | 3.00 | 11.00 | 2.00 | 1.148 | 0.251 |
| Verbal intelligence section | 98.00 | 12.00 | 107.00 | 8.00 | 3.959 | <0.001 |
| Performance intelligence section | 104.00 | 13.00 | 104.00 | 9.00 | 1.433 | 0.152 |
| Total intelligence section | 102.00 | 13.00 | 106.00 | 9.00 | 3.210 | <0.001 |
| RSPMa | 9.00 | 2.00 | 10.00 | 3.00 | 2.758 | 0.006 |
| RSPMb | 6.00 | 4.00 | 9.00 | 5.00 | 3.749 | <0.001 |
| RSPMc | 4.00 | 3.00 | 7.00 | 4.00 | 4.735 | <0.001 |
| RSPMd | 3.00 | 5.00 | 6.00 | 5.00 | 4.463 | <0.001 |
| RSPMe | 1.00 | 2.00 | 2.00 | 4.00 | 3.956 | <0.001 |
| RSPM total score | 22.00 | 12.00 | 34.00 | 17.00 | 5.010 | <0.001 |
| RSPM duration (minutes) | 34.00 | 14.00 | 36.00 | 21.00 | 1.767 | 0.077 |

RSPM: Raven Standard Progressive Matrices Test, WISC-R: Wechsler Intelligence Scale for Children, Z: Mann-Whitney U Test

significant difference (p=0.004) was found between attention deficit and control groups but differences between other groups were not found statistically significant (p>0.05). In Digit Span sub-test, statistically significant difference was found between groups ($\chi^2$=12.509; p=0.006). When the origin of difference was examined, significant difference (p<0.001) was found between attention deficit and control groups but differences between other groups were not found statistically significant (p>0.05).

When sub-tests of Performance Intelligence Section were examined, statistically significant difference was found between Picture Completion and Coding sub-tests. Statistically significant differences were found between groups in Picture Completion sub-test ($\chi^2$=17.063; p<0.001). When the origin of difference was examined, significant differences were found between attention deficit and hyperactivity (p=0.008) and attention deficit and control groups (p<0.001) but other groups were found statistically similar (p>0.05). In Coding sub-test, statistically significant differences were found between groups ($\chi^2$=13.655; p=0.003). When the origin of difference was examined, significant differences were found between attention deficit – hyperactivity (p=0.004) groups but differences between other groups were not statistically important (p>0.05).

In Verbal Intelligence Section, statistically significant differences were found between groups ($\chi^2$=23.694; p<0.001). When the origin of difference was examined, significant difference was found between attention deficit and control groups (p<0.001) but statistically important difference was found between other groups (p>0.05). In Performance Intelligence Section sub-test, statistically significant differences were found between groups ($\chi^2$=10.843; p=0.013). When the origin of difference was examined, significant difference was found between attention deficit and hyperactivity (p=0.005) and attention deficit and control groups (p=0.002) but no statistically important differences were found between other groups (p>0.05). In Total

Intelligence Section sub-test, statistically significant differences were found between groups ($\chi^2$=20.836; p<0.001). When the origin of difference was examined, significant difference was found between attention deficit and hyperactivity (p=0.003) and attention deficit and control groups (p<0.001) but no statistically important differences were found between other groups (p>0.05).

When RSPM was examined, groups showed statistically significant differences at all sub-tests except RSPM-A and total score (p<0.05) but scale response duration was not found statistically significant (p>0.05) (Table 1). Differences were found between RSPM-B combined type and control (p<0.001), RSPM-C attention deficit and control (p<0.001) and combined type and control (p<0.001), RSPM-D attention deficit and control (p<0.001) and combined type and control (p<0.001), RSPM-E attention deficit and control (p=0.004) and combined type and control (p=0.003), RSPM Total Score attention deficit and control (p<0.001), hyperactivity and control (p=0.006) and combined type and control (p<0.001) groups.

Correlation between WISC-R and RSPM was examined by Spearman sequential correlation coefficient. By this method, a weak, positive but significant correlation was found between mathematics grade and RSPM total score. Other significant correlations were shown at Table 2. Moderate or strong correlation was not found between WISC-R and RSPM.

## DISCUSSION

Participants from control group obtained higher scores at all sub-tests from analyses in this study. Among ADHD sub-types, differences were obtained at picture completion (attention deficit<hyperactivity) and coding (attention deficit<hyperactivity) sub-test scores. Differentiating ADHD sub-types by coding and picture completion sub-tests is consistent with the literature (42-44). Coding sub-test which is a working memory task requiring matching visual stimuli with certain numbers and doing this process in a mixed pattern and in a certain amount of time assesses perseverance level, power to adjust changing conditions, visual-motor coordination, fine motor coordination and speed (45). Picture completion sub-test assesses perception capacity of peripheral stimuli, level of interest towards environment and details, visual agility and power of memory (5). There are study findings about impairment of domains mentioned in ADHD (46-49). Our finding is consistent with the literature. Finding differences between sub-types is an important contribution. Lower scores at sub-tests in sub-types with predominant attention deficit can be used to detect co-morbid learning disorder. Because understanding time and event system, time-bound speed and sequencing are important problematic fields for both psychopathologies. Assessment of children obtained lower scores from this sub-test of WISC-R for learning disorder may be important for treatment.

WISC-R is a test assessing "g" factor of Spearman, i.e., general intelligence but also is affected by cultural factors (50). RSPM also assesses general intelligence like WISC-R. However, RSPM which assesses abstract reasoning and analytical intelligence is a culturally balanced test which does not consists of verbal material (2). Moreover, RSPM is less affected from socio-economic level and sensory and motor skills compared to other tests. RSPM assesses judgement, regular and accurate thinking skills and mental skills and activity speed without academic achievement and verbal skills. For this reason, RSPM is among the best predictors of general intelligence (2,51). Factor analysis studies done on RSPM showed that this test also assesses visual-spatial perception skills which is called as "K" factor (49). In our study, RSPM was used to assess analysis, regular and accurate thinking skills, mental skills and activity speed, general aptitude, visual-spatial processes and analytical intelligence.

When standardization study results of RSPM at Turkish children between 6 and 15 years old and results of the healthy sample in this study are examined altogether, it was observed that correlations between RSPM sub-test scores and sub-test averages in age groups were found to be close to each other (38). Yalçın (52) found significant correlations between age and RSPM sub-test scores and duration scores. In that

study, relationship between RSPM and meta-cognition, executive functions and cognitive development was also examined. It was found that RSPM is more correlated with characteristics assessed by Logical Thinking Test. In our study, analyses showed the significance of group effect, differences were achieved for scores other than RSPM A and RSPM Duration. When duration-score averages were examined, it was observed that children at the ADHD-AD sub-type spent more time to complete the test. Another reason for lack of difference for duration-score in the test can be explained by controllability of impulsive reactions of the test's structure. As already known, RSPM is a test consist of 5 sets each consisting of 12 items. Every new set started support innovation search and generates pleasure of completing a task. Thus, each completed set becomes a reward for the new test starting. Delay aversion diminishes by this way. RSPM has properties of being an efficient tool for follow-up of ADHD. Our study findings are consistent with findings reported by Soysal (3) and Kiriş and Karakaş (4). These studies are important because they are among few studies which ADHD was evaluated by RSPM and WISC-R together.

In our study, we found that WISC-R and RSPM did not predict mathematics achievement. Our study showed that there is not any head-to-head linear correlation between mathematical operational skills and cognitive activity speeds. This indicates the reason of failures of participants with worse mathematics skills and they are not at lower levels mentally. For this reason, presence of mathematics achievement tests is important to determine knowledge gaps. There is no test to determine mathematics achievement in Turkey. This study is important to mention this absence.

## CONCLUSION

The contribution of this study to literature is showing that mathematics skills are correlated with learning processes rather than cognitive performance. For this reason, utilization of mathematics achievement tests in children with ADHD may enhance academic success by combining obtained results with behavioral therapy. Further studies with wider samples including girls, interviewing success criteria with teachers and including different psychopathologies such as learning disorders will contribute to literature.

## REFERENCES


1. Wechsler D. The Measurement And Appraisal Of Adult Intelligence. 4th edition. Baltimore: Williams&Wilkins, 1958.
2. Lezak MD. Neuropsychological Assessment. 2nd edition. New York: Oxford Univ. Pr, 1995.
3. Soysal AŞ. Dikkat eksikliği hiperaktivite bozukluğu alttiplerinde dikkat, yönetici işlevler ve üst-biliş performansının oluşturduğu ilişkiler örüntüsünün incelenmesi. Doktora Tezi, Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara, 2007 (Thesis in Turkish).
4. Kiriş N, Karakaş S. Dikkat eksikliği hiperaktivite bozukluğunun Wechsler Zeka Testi ve Raven Standart Progresif Matrisler Testi ile analizi. Klinik Psikiyatri Dergisi 2005; 8:5-17 (Article in Turkish).
5. Anastasia A. Psychological Testing. 6th edition. New York: Macmillian Publishing Company, 1990.
6. Peterson CR. Heart DH. Factor structure of the WISC-R for a clinical-referred population and specific subgroups. J Consult Clin Psychol 1979; 47:643-645.
7. Thompson RJ. The diagnostic utility of WISC-R measures with children referred to a developmental evaluation center. J Consult Clin Psychol 1980; 48:440-447.
8. Soysal AŞ, Karateke B, Çopur A, Kılıç KM, Akay S. The relationship between WISC-R scores of children with attention deficit and hyperactivity disorder and problem solving skills of their mothers. Düşünen Adam: The Journal of Psychiatry and Neurological Sciences 2010; 23:256-264.
9. Banattayne A. Diagnosis: a note on recategorization of the WISC scaled scores. J Learn Disabil 1974; 7:272-273.
10. Culberton FM, Fral CH, Gabby S. Pattern analysis of Wechsler Intelligence Scale For Children-Revised profiles of delinquent boys. J Clin Psychol 1989; 45:651-660.
11. Doyle AF, Biederman J, Seidman L, Weber W, Faraone SV. Diagnostic efficiency of neuropsychological test scores for discriminating boys with and without attention deficit hyperactivity disorder. J Consult Clin Psychol 2000; 68:477-488.

12. Soysal AŞ, İlden Koçkar A, Erdoğan E, Şenol S, Gücüyener K. Dikkat eksikliği hiperaktivite bozukluğu olan bir grup hastanın WISC-R profillerinin incelenmesi. 3P Dergisi 2001; 9:205-212 (Article in Turkish).

13. Soysal AŞ, İlden Koçkar A, Erdoğan E, Şenol S, Gücüyener K. Özgül öğrenme güçlüğü olan bir grup hastanın WISC-R profillerinin incelenmesi. Klinik Psikiyatri Dergisi 2001; 4: 225-231 (Article in Turkish).

14. Rourke BP. Central processing deficiencies in children: toward a developmental neuropsychological model. J Clin Neuropsychol 1982; 4:1-18.

15. Banattayne A. Diagnosing learning disabilities and writing remedial prescription. J Learn Disabil 1968; 1:242-249.

16. Rugel RP, Rosenthal RS. Skin conductance, reaction time, and observational ratings in learning-disabled children. J Abnorm Child Psych 1974; 2:183-192.

17. Korkmazlar Ü. 6-11 yaş ilkokul çocuklarında özel öğrenme bozukluğu ve tanı yöntemleri. Doktora Tezi, İstanbul Üniversitesi Tıp Fakültesi, İstanbul, 1992 (Thesis in Turkish).

18. Lawson JS, Inglis J. Learning disabilities and intelligence test results: a model based on a principal components analsis of the WISC-R. Br J Psychol 1985; 76:35-48.

19. Ottem E. Interpreting the WISC-R subtest scores of reading impaired children- a structural approach. Scand J Psychol 1998; 39:1-7.

20. Ottem E. Do the Wechsler scales underestimate the difference between verbal and performance abilities in children with language-related disorders? Scand J Psychol 2002; 43:291-298.

21. Biederman J, Faraone SV. Attention-deficit hyperactivity disorder. Lancet 2005; 366:2237-2248.

22. Facoetti A, Lorusso ML, Paganoni P, Cattaneo C, Galli R, Umiltà C, Mascetti GG. Auditory and visual automatic attention deficits in developmental dyslexia. Brain Res Cognit Brain Res 2003; 16:185–191.

23. Öngider N, Baykara B, Akay AP. Bir çocuk psikiyatrisi polikliniğinde ayaktan izlenen olgulardan DEHB ve/veya ÖÖB tanısı konan çocukların WISC-R testi sonuçlarının karşılaştırılması. Yeni Symposium 2008; 46:17-22 (Article in Turkish).

24. Fergusson DM, Horwood LJ. Attention deficit and reading achievement. J Child Psychol Psychiatry 1992; 33:375–385.

25. Helland T, Asbjornsen A. Digit span in dyslexia: variations according to language comprehension and mathematics skills. J Clin Exp Neuropsychol 2004; 26:31-42.

26. Zentall SS, Smith YN, Lee YB, Wieczorek C. Mathematical outcomes of attention-deficit hyperactivity disorder. J Learn Disabil 1994; 27:510-519.

27. Verguts T, Boeck PD. The Induction of solution rules in Raven's progressive matrices test. Eur J Cogn Psychol 2002; 14: 521–547.

28. Burke HR. Raven's Progressive Matrices (1938): More on norms, reliability and validity. J Clin Psychol 1985; 41:513-546.

29. Carpenter P, Just MA, Shell P. What one intelligence test measures: A theorical account of the processing in the Raven's Progressive Matrices Test. Psychol Rev 1990; 97:404-431.

30. Khalek AM. Egyptian results on the Standart Prograssive Matrices for Hispanic and Nonhispanic seventh-grade students. Personal Individual Differences 1988; 9:193-195.

31. Raven JC, Court JH, Raven J. Manual for Raven's Standart Progressive Matrices. Oxford: Oxford Psychologists Pr, 1992.

32. Guilford JP, Hoepfner R. The analysis of Intelligence. New York: McGraw-Hill, 1971.

33. Michael DN. Forecasting and planning in an incoherent context. Technol Forecast Soc Change 1989; 36:79-87.

34. Piaget J. The psychology of Intelligence. Oxford: Littlefield Adams, 1972.

35. Raven'ın Standard Progressive Matrices Testinin Normal ve Normal-Üstü Öğrencilerin İleriki Matematik Başarısını Kestirebilmesi," VIII. Ulusal Psikoloji Kongresi Bildiriler Kitabı, 1995 (Article in Turkish).

36. Kuntsi J, Oosterlaan J, Stevenson J. Psychological mechanisms in hyperactivity: I. Responce inhibition deficit, working memory impairment, delay aversion, or something else? J Child Psychol Psychiatry 2001; 42:199-210.

37. Şenol S, Şener S. Dikkat Eksikliği Hiperaktivite Bozukluğu: İçinde Güleç C, Köroğlu E (Editörler). Psikiyatri Temel Kitabı. 2. Cilt. Ankara: Hekimler Yayın Birliği, 1999, 1119-1130 (Book in Turkish).

38. Özcan E, Eğri M, Kutlu O, Yakıncı C, Karabiber H, Genç M. Okul çağı çocuklarında DEHB yaygınlığı: Ön çalışma. Turgut Özal Tıp Merkezi Dergisi 1998; 5:138-142 (Article in Turkish).

39. Savaşır I, Şahin N. Wechsler Çocuklar İçin Zeka Ölçeği (WISC-R) El Kitabı. Ankara, Türk Psikologlar Derneği Yayınları, 1995, 13-52 (Article in Turkish).

40. Raven J, Court JH. Manual for Raven's Progressive Matrices and Vocabulary Scales. Oxford: Information Press, 1993.

41. Şahin N, Düzen E. Turkish standardization of the Raven's SPM (6-15 Ages). 23rd International Congress of applied Psychology, 1993.

42. Bowers MG, Risser JF, Suchanec DE, Tinker DE, Ramer JC, Domoto M. A developmental index using the Wechsler Intelligence Scale for Children: implication for the diagnosis and nature of ADHD. J Learn Disabil 1992; 25:179-185.

43. Lufi D, Cohen A. Using the WISC-R to identify attentional deficit disorder. Psychol Sch 1985; 22:40-42.

44. Worland J, North-Jones M, Stern JA. Performance and activity of hyperactive and normal boys as a function of distraction and reward. J Abnorm Child Psych 1973; 1:363-377.

45. Palmer JO. The Ppsychological Assessment of Children. New York: John Wiley&Sons Inc,1983.

46. Doyle AE, Faraone SV, Seidman LJ, Willcutt EG, Nigg JT, Waldman ID, Pennington BF, Peart J, Biederman J. Are endophenotypes based on measures of executive functions useful for molecular genetic studies of ADHD? J Child Psychol Psychiatry 2005; 46:774-803.

47. Doyle AE. Executive function in attention deficit/hyperactivity disorder. J Clin Psychiatr 2006; 67 (Suppl.8):21-26.

48. Nigg JT, Blaskey LG, Stawicki JA, Sachek J. Evaluating the endophenotype model of ADHD neuropsychological deficit: results for parents and siblings of children with ADHD combined and inattentive subtypes. J Abnorm Psychol 2004; 113:614-625.

49. Sergeant J A, Geurts H, Oosterlaan J. How specific is a deficit of executive functioning for attention-deficit/hyperactivity disorder? Behav Brain Res 2002; 130:3-28.

50. Kaufman AS. Factor analysis of WISC-R at eleven age levels between 6½ and 16½ years. J Consult Clin Psychol 1975; 43:135-147.

51. Kurt M, Karakaş S. Sağ serebral hemisferin bilişsel işlevlerine duyarlı nöropsikoloik testlerin özellikleri ve aralarındaki ilişkiler. 3P Dergisi 2000; 8:251-265 (Article in Turkish).

52. Yalçın K. Çocuklarda yaş ile üst-bellek türleri arasındaki ilişki. Yüksek Lisans Tezi. Hacettepe Üniversitesi, Sosyal Bilimler Enstitüsü, Ankara, 2006 (Thesis in Turkish).