EXECUTIVE FUNCTIONS IN CHILDREN WITH ATTENTION DEFICIT / HYPERACTIVITY DISORDER

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REYHAN BAHÇİVAN-SAYDAM

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Approval of the Graduate School of Social Sciences

_____

Prof. Dr. Sencer Ayata
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

_____

Prof. Dr. Nebi Sümer
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

_____

Assoc. Prof. Belgin Ayvaşık
Supervisor

Examining Committee Members

Assoc. Prof. Tülin Gençöz	(METU, PSY)	_____
Assoc. Prof. Belgin Ayvaşık	(METU, PSY)	_____
Assoc. Prof. Nurhan Er	(AU, PSY)	_____
Prof. Dr. Arşaluys Kayır	(IU, PSYCHI)	_____
Assoc. Prof. Şennur Tutarel Kışlak	(AU, PSY)	_____

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Name, Last Name : Reyhan, Bahçıvan-Saydam
Signature :

ABSTRACT

EXECUTIVE FUNCTIONS
IN CHILDREN WITH
ATTENTION DEFICIT / HYPERACTIVITY DISORDER

Reyhan, Bahçıvan-Saydam
Ph.D., Graduate School of Social Sciences / Department of Psychology
Supervisor: Assoc. Prof. Dr. Belgin Ayvaşık

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Aim of the present study was to evaluate executive functions (EF) such as inhibition, planning, working memory, set-shifting in children with Attention Deficit / Hyperactivity Disorder (ADHD) via comparison of three ADHD subtype groups (ADHD-I, ADHD-C and ADHD-Comorbid) and a normal control group. Participants consist of 147 children. Total of 111 children were assigned into the ADHD groups of the study. Thirty seven children (5 girl and 32 boys) were assigned into the ADHD-Inattentive group, thirty seven children (6 girls and 31 boys) were assigned into the ADHD-Combined group; and thirty seven children (4 girls and 33 boys) were classified as ADHD-Comorbide group (ADHD-C with Oppositional Defiant Disorder consists of 4 girls and 31 boys, and/or Conduct Disorders consists of 2 boys). Thirty six children (6 girls and 30 boys; age range: 7-12) were assigned as control group by matching with the ADHD groups according

to the WISC-R Full Scale IQ score, sex and age. Conner's Parental and Teacher Rating Scales, Child Behavior Check List and Wechsler Intelligence Scale Revised, Tower of London Test, Wisconsin Card Sorting Test, Stroop Color Word Test, Cancellation Task, Trail Making Test, California Verbal List Test for Children, Verbal Fluency Test, Continuous Performance Test, Go-No-Go Task and Bender-Gestalt Test were used for the assessment of children. The data were analyzed by one-way within subject ANOVA for all dependent variables measured by the assessment tools. Additionally discriminant function analyses were conducted to determine the variables that differentiate the three ADHD groups and control group. Outcome of study indicated that subjects in ADHD-Comorbid group had more severe Executive Function (EF) deficits than subjects in ADHD-I and ADHD-C group. The findings were discussed in the light of the literature.

Keywords: Attention Deficit / Hyperactivity Disorder, ADHD-Inattentive, ADHD-Combined, ADHD-Comorbid, Executive Functions.

ÖZ

DİKKAT EKSİKLİĞİ / HİPERAKTİVİTE BOZUKLUĞU OLAN
ÇOCUKLARDA
YÜRÜTÜCÜ / YÖNETİCİ İŞLEVLER

Reyhan, Bahçıvan-Saydam
Doktora, Sosyal Bilimler Enstitüsü / Psikoloji Bölümü
Tez Yöneticisi: Doç. Dr. Belgin Ayvaşık

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Bu çalışmanın amacı Dikkat Eksikliği ve Hiperaktivite Bozukluğu olan çocuklarda, yürütücü / yönetici işlevleri (planlama, çalışma belleği, ortama uygun tepki geliştirebilme, inhibisyon) değerlendirmektir. Dikkat Eksikliği Hiperaktivite Bozukluğu (DEHB)-Dikkatsiz Tip, DEHB-Kombine Tip, DEHB-Komorbid Tip ve Kontrol Grubundan oluşan dört ayrı grup çalışma içinde yer almıştır. Çalışmaya toplam 147 çocuk katılmış olup, 37 tanesi (5 kız, 32 erkek) DEHB-Dikkatsiz Tip, 37 tanesi (6 kız, 31 erkek) DEHB- Kombine Tip, 37 tanesi (4 kız, 33 erkek) DEHB- Komorbid Tip, 36 tanesi (6 kız, 30erkek) Kontrol Grubunda yer almıştır. Araştırmada Conner's Ebeveyn ve Öğretmen Değerlendirme Ölçeği, Çocuk Davranış Değerlendirme Ölçeği, WISC-R Zeka Testi, Londra Kulesi Testi, Wisconsin Kart Eşleme Testi, Stroop Testi, California Sözel Öğrenme Testi Çocuk

Versiyonu, Sözel Akıcılık Testi, Sürekli Performans Testi, İşaretleme Testi, Dur-Durma Testi ve Bender-Gestalt Testi kullanılmıştır. Gruplar içinde tek yönlü varyans analizi (ANOVA) kullanılmıştır. Üç ADHD alt-grubu ve kontrol grubunu ayrıştırmak ve belirleyici değişkenleri saptamak amacıyla ayrıştırma (diskriminant) analizi uygulanmıştır. Araştırmanın sonucuna göre yürütücü / yönetici işlevleri en fazla bozulan grubun DEHB-Komorbid grup olduğu gözlenmiş olup, diğer DEHB-Dikkatsiz ve DEHB-Kombine gruplarında daha hafif düzeyde bozulma olduğu tespit edilmiştir. Bulgular literatür ışığında tartışılmıştır.

Anahtar Kelimeler: Dikkat Eksikliği / Hiperaktivite Bozukluğu, DEHB-Dikkatsiz, DEHB-Kombine, DEHB-Komorbid, Yürütücü / Yönetici İşlevler

DEDICATION

To ŞİİR SU

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INTRODUCTION

Attention deficit / hyperactivity disorder (AD/HD) is a common, early-onset neuropsychiatric / developmental, behavioral disorder. ADHD is a chronic condition that severely impairs function both at home and in school, and frequently persists into adulthood. It is characterised by symptoms of inattention, hyperactivity and impulsivity (Frank, 1996, Biederman et al., 2006, Kaplan and Sadock, 1998). ADHD is sustained by excessive and inappropriate situational motor behavior, limited inhibitory control of responses, and inability to focus, sustain and switch attention (Barkley, 1997, Frank, 1996, Biederman et al., 2006).

ADHD is a condition that generally becomes apparent in the preschool and early school years, and is one of the most prevalent, well-studied childhood psychopathological conditions. Symptoms of ADHD might cause social, academic, and occupational impairment (Biederman et al., 2006). Barkley, DuPaul and McMurray (1990) evidenced that the presence of significant inattention is associated with greater problems in behavioral, academic, and social adjustmental areas. Children with ADHD often display substantial problems when interacting with other children such as being bossy, boastful, physically and verbally aggressive (Barkley, 1997). It is estimated that 3-5% of children have this disorder and half of them display the problems into adulthood; the male / female ratio is 3-5 to 1 (Squire, Bloom, Mc Connell, Roberts, Spitzer and Zigmond, 2003, Kaplan and Sadock, 1998).

Over the past few decades, the terminology, diagnostic criteria, and knowledge on the etiology of the symptoms such as inattention, hyperactivity, and impulsivity has undergone various changes (Brassett-Harknett and Butler, 2007;

Stefanatos and Baron, 2007). The first formal description of AD/HD was made by an English physician George Still in 1902 as "defects in moral control" (as cited in Stefanatos and Baron, 2007) referring to a study with 43 children. He described those children who demonstrated incapacity for sustained attention, restlessness, violent outbursts, destructiveness, noncompliance, little inhibitory control, resistance to discipline, and sometimes cruel and dishonest behavior (Stefanatos and Baron, 2007). During World War I, children with symptoms of impaired inattention, dysregulated behavior, and impulsivity after an encephalitic infection were described as having Postencephalitic Behavior Disorder (Hetchman, 2005). In mid 20th century, Minimal Brain Dysfunction (MBD) term was hypothesized suggesting a link between inattentive hyperactive behavior and brain dysfunction (Lezak, 2004).

In the Diagnostic and Statistical Manual of Mental Disorders, Second Edition (DSM-II) the AD/HD was assessed under the name of "Hyperkinetic Reaction of Childhood", and was characterized by overactivity, restlessness, distractibility, and short attention span (Stefanatos and Baron, 2007). The disorder was renamed as Attention Deficit Disorder (ADD) with or without Hyperactivity in DSM-III, which lead to an important change in the conceptualization of the disorder, with attention deficit and impulsivity, considered to be defining characteristics and hyperactivity as a possible but not required feature (Öner and Aysev, 2007). The studies on the AD/HD grew up in the past 20 years. In DSM-IV, the disorder was termed as Attention-Deficit/ Hyperactivity Disorder and the diagnostic criteria were developed through field studies in the aim of testing the validity of symptoms (Öner and Aysev, 2007).

Diagnosis and Evaluation of ADHD

According to Diagnostic and Statistical Manual of Mental Disorders-IV-TR (DSM-IV-TR; APA, 2000), three patterns of persistent behavior which are "inattention", "hyperactivity" and "impulsivity", are the diagnostic criteria of ADHD and are differentially expressed in three subtypes: primarily inattentive,

primarily hyperactive/impulsive or combined in type. The fourth, unspecified subtype of ADHD is named as "Not Otherwise Specified (NOS) Type". However, in the International Classification of Diseases 10th edition (ICD-10; WHO, 1993), all three behaviors (inattention, hyperactivity and impulsivity) must be present for the diagnosis of "Hyperkinetic Disorder", which thus has no subtypes.

Diagnosis is basing on behavioral criteria, and a designated number of symptoms must be experienced in individuals before the age of seven years, in two or more settings and cause significant problems in social (family, peers) and academic (school) areas. Even though DSM-IV-TR describes three diagnostic subtypes of ADHD, the definition of ADHD based on elevations of two separate but correlated symptom dimensions, which are inattention and hyperactivity/impulsivity.

Children with the diagnosis of ADHD Inattentive type, in other words Predominantly Inattentive subtype (ADHD-I) have six or more symptoms of inattentiveness but less than six symptoms of hyperactivity/impulsivity. ADHD hyperactive/impulsive type or predominantly Hyperactive/Impulsive Subtype (ADHD-H) displays six or more symptoms of hyperactivity/impulsivity but fewer than six symptoms of inattentiveness. However, children with diagnosis of ADHD-Combined subtype (ADHD-C) are displaying both inattentive and hyperactive-impulsive symptoms (APA, 2000; Chhabildas, Pennington and Willcutt, 2001, Squire, Bloom, Mc Connell, Roberts, Spitzer and Zigmond, 2003; Willcutt, Doyle, Nigg, Faraone and Pennington, 2005). These symptoms must be present for at least six months in two or more different settings, such as school, work, and home. In addition, the symptoms must be present before the patient has reached the age of seven and must show "clear evidence of clinically significant impairment in social, academic, or occupational functioning" (DSM-IV-TR, 2000). The last type of ADHD, the NOS subtype, does not appear in the literature outside of the DSM-IV. The DSM-IV-TR criteria for ADHD are presented in Table 1 (DSM-IV TR; APA, 2000):

Table 1. DSM-IV-TR criteria for ADHD:

A. *Either (1) or (2)* ***(1)*** *Six (or more) of the following symptoms of inattention have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level:* ***Inattention*** *—Often fails to give close attention to details or makes careless mistakes in school work, work, or other activities.* *—Often has difficulty sustaining attention in tasks or play activities.* *—Often does not seem to listen when spoken to directly.* *—Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not to do to oppositional behavior or failure to understand instructions).* *—Often has difficulty organizing tasks and activities.* *—Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework).* *—Often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools).* *—Is often easily distracted by extraneous stimuli.* *—Is often forgetful in daily activities.* ***(2)*** *Six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least six months to a degree that is maladaptive and inconsistent with developmental level:* ***Hyperactivity*** *—Often fidgets with hands or feet or squirms in seat.* *—Often leaves seat in classroom or in other situations in which remaining seated is expected.* *—Often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, they are limited to subjective feelings of restlessness).* *—Often has difficulty playing or engaging in leisure activities quietly.* *—Is often "on the go" or often acts as if "driven by a motor."* *—Often talks excessively.* ***Impulsivity*** *—Often blurts out answers before questions have been completed.* *—Often has difficulty awaiting turn.* *—Often interrupts or intrudes on others (e.g., butts into conversations or games).* ***B****. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age seven years.* ***C.*** *Some impairment from both symptoms is present in two or more settings (e.g., at school or work, and at home).* ***D.*** *Clear evidence of clinically significant impairment in social, academic, or occupational functioning.*
E. *The symptoms do not happen exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder. The symptoms are not better accounted for by another mental disorder (e.g. Mood Disorder, Anxiety Disorder, Dissociative Disorder, or a Personality Disorder).*

Based on these criteria, three types of ADHD are identified:

1. *ADHD, Combined Type: if both criteria A1 and A2 are met for the past 6 months*
2. *ADHD, Predominantly Inattentive Type: if criterion A1 is met but criterion A2 is not met for the past six months*
3. *ADHD, Predominantly Hyperactive-Impulsive Type: if Criterion A2 is met but Criterion A1 is not met for the past six months*

and, 4. ADHD, not otherwise specified [NOS])

Children, who are inattentive, have difficulty to pay conscious attention in organizing and completing a task. Learning something new is difficult; they often become easily distracted by irrelevant sights and sounds, failing to pay attention to details and making careless mistakes, rarely following instructions carefully and completely losing or forgetting things like toys or pencils, books, and tools needed for a task (Kaplan and Sadock, 1998).

Children with the diagnosis of hyperactivity are always running around, and touching whatever is in sight, or talking incessantly. Sitting still at dinner or during a school lesson or watching TV can be a difficult task for them. Most outstanding peculiarity of impulsive children is being unable to control their immediate reactions or to think before they act. They often display their emotions without restraint, and act without thinking of the later consequences of their behavior.

Children who are hyperactive-impulsive, display the signs of feeling restless, often fidgeting with hands or feet, or squirming while seated, running, climbing, or moving around where sitting or quiet behavior is expected, giving immediate answers before hearing the whole question, having difficulty waiting in line or taking turns (NIMH, 2003).

ADD with Hyperactivity (ADD+H) is associated with greater problems such as considerably less self-control, greater impulsivity, and markedly worse internalizing and externalizing problems than is likely to be seen in ADD without

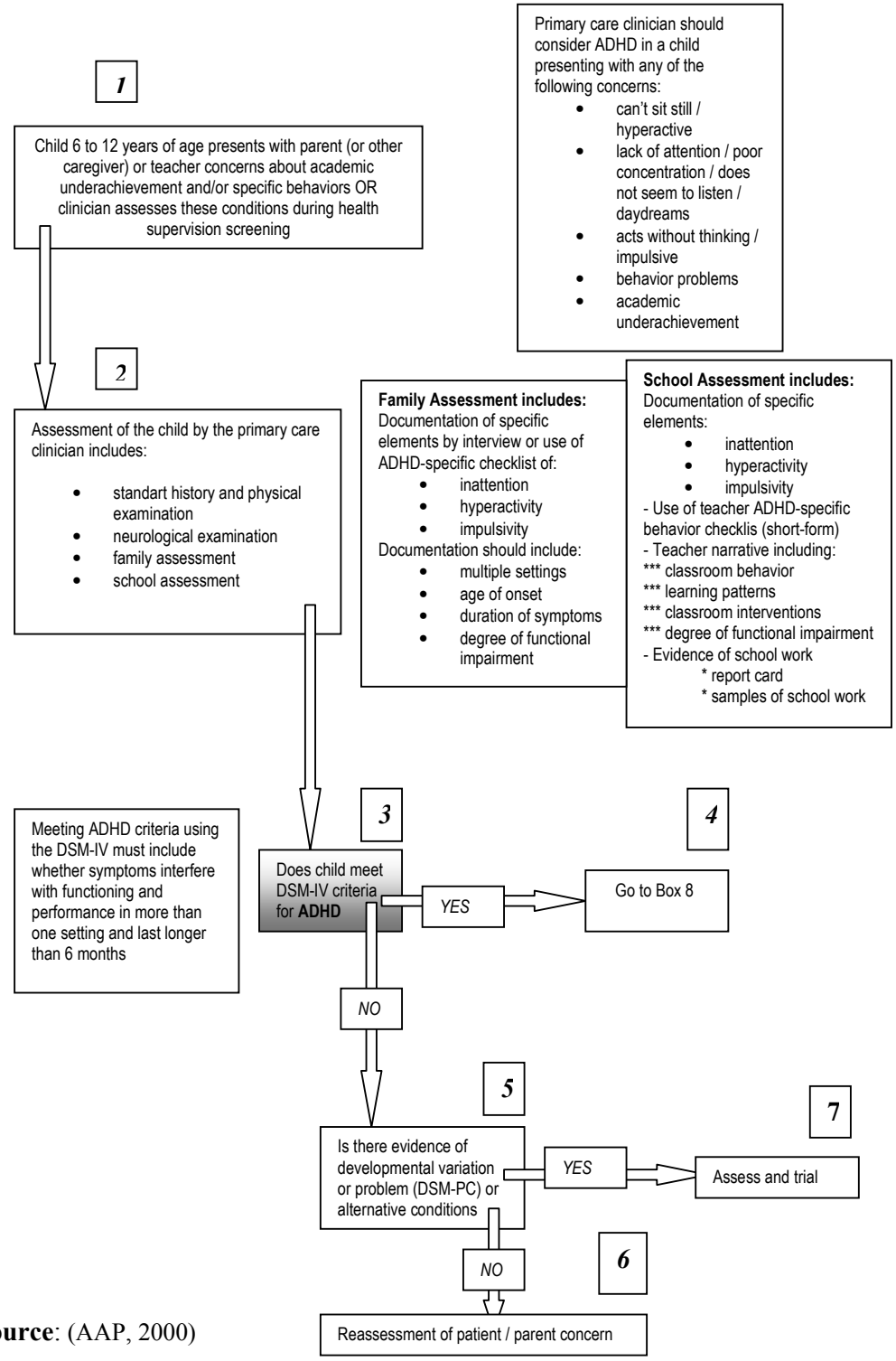
hyperactivity (ADD-H). In addition, children with ADD+H type have more than twice the diagnosis of Oppositional Defiant Disorder (ODD) and more than three times the diagnosis of Conduct Disorder (CD) compared to the ADD-H children (Barkley, DuPaul and McMurray, 1990). Children with ADHD-I subtype are more likely to develop comorbid mood and anxiety disorders as well as learning problems, whereas children with ADHD-C type are more likely to have CD, ODD and Substance Use Disorders (Biederman et al., 2006). Outcome of assessing usefulness of Child Behavior Check List (CBCL) parent ratings for discriminating subtypes of ADHD-I and ADHD-C indicated that aggressive behavior scale was slightly better at predicting ADHD-C than ADHD-I students; additionally ADHD-C students were more likely to exhibit high levels of depression and display impairments across all of the externalizing dimension (Ostrander, Weinfurt, Yarnold and August 1998).

According to Hill and Cameron (1999), the Predominantly Inattentive type (ADHD-I), appears to be apathetic, confused and to have slow or inefficient information processing rather than the more cognitive-motivational elusive, self-regulatory deviant, and restless hyperactive. In addition, children with ADHD-I are more prone to day dreaming, spacing out, being in fog; they are easily confused, lethargic, hypoactive and passive. They generally have deficits in speed of information processing, especially with deficits in focused or selective attention. On the other hand, children with ADHD-C type have deficits in persistence of sustained attention and distractibility, and the hyperactive-impulsive behavior pattern might occur first in early development, during the preschool years, while symptoms of inattentiveness appear to have their onset several years later, at least according to parental reports (Barkley, 1997). Children with ADHD-C type might develop into the inattentive type, because as they get older, they have reduction in their hyperactive behavior (Rutter, 1990).

Establishing the ADHD diagnosis requires the avoidance of over- as well as under-identification. For an accurate diagnosis, the use of the specific DSM-IV TR

criteria can be helpful. A clinical algorithm for the diagnosis and evaluation of the child with ADHD, prepared by the "American Academy of Pediatrics, Committee on Quality Improvement - Subcommittee on Attention-Deficit / Hyperactivity Disorder" is shown in Figure 1 (AAP, 2000):

A



Source: (AAP, 2000)

Figure 1. Diagnosis and Evaluation of the Child with Attention-Deficit / Hyperactivity Disorder: Clinical Algorithm

B

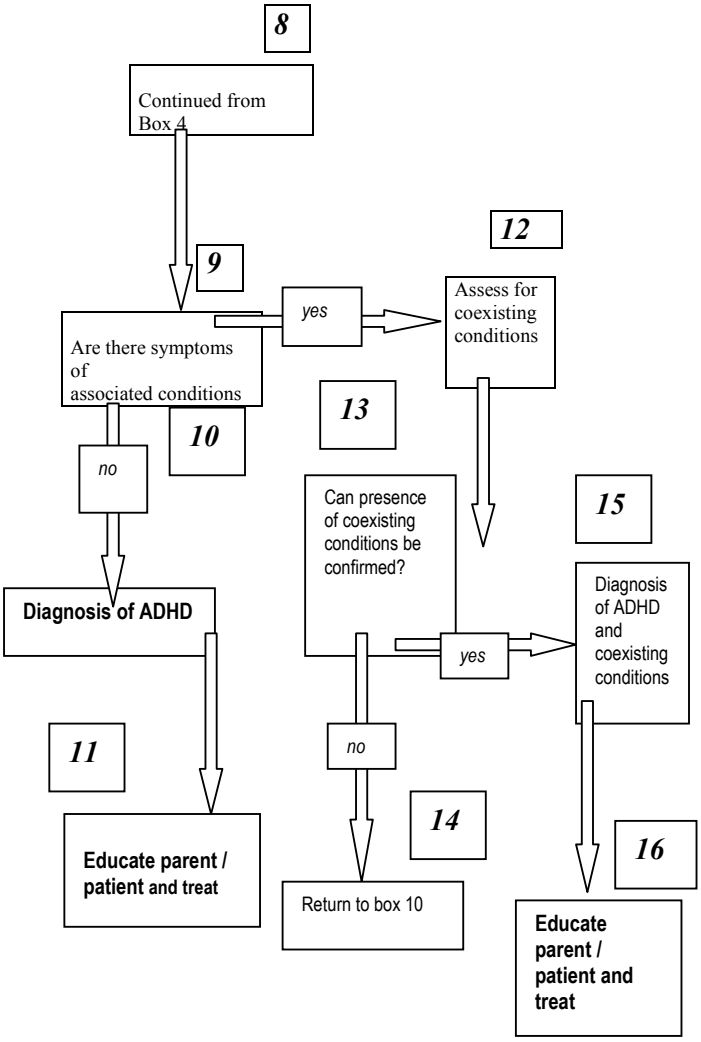


Figure 1 (cont'd). Diagnosis and Evaluation of the Child with Attention-Deficit / Hyperactivity Disorder: Clinical Algorithm (AAP, 2000)

1.1. Etiology of ADHD

The etiology of ADHD has still not been concretely worked out. Various factors such as environmental (e.g. parental attitude), nutritional (food additives and sugar) and brain injurial, as well as genetic ones are considered (Biederman et al., 2006; Hetchman, 2005; Wilmshurst, 2005).

The study of the structure of the brain is helpful in understanding the neuroanatomical and the physical basis for ADHD. Functions of attention such as focusing, executing, sustaining and shifting attention involve different brain regions interconnected and organized into a system (Lezak, Howieson and Loring, 2004). Therefore attentional system is widespread in different parts of brain structures including prefrontal cortex, temporal cortex, corpus striatum and hippocampus (Hetchman, 2005). Castellanos et al. (2002) evidenced that ADHD children showed 3-4 % smaller brain volumes in all regions -the frontal lobes, temporal gray matter, caudate nucleus, and cerebellum- than children in control groups. In addition brain scans with functional magnetic resonance imaging (fMRI) and single photon emission computed tomography (SPECT) have revealed less activity in the frontal brain regions and more activity in the cingulated gyrus in children with ADHD compared to normal children (Wilmshurst, 2005). On the other hand, Biederman, Safran, Seidman, Spencer and Wilson (2006), underline that although neuroimaging studies establish ADHD as a brain disorder, using them for diagnosing ADHD is not useful because of existing inter-patient variability.

Although the neurobiological basis of ADHD is still unresolved, recent advances in molecular genetics and brain imaging have improved our understanding of the disease, and indirect evidence increasingly implicates dopaminergic hypofunction in the frontal lobes and basal ganglia. No single gene abnormality reliably predicts ADHD but several molecular genetic studies have found evidence that children with ADHD have genetic variations in one of the dopamine-receptor genes (DRD-4) on chromosome 11. But the presence of such a variation seems to be associated with only a modest increase in the risk of

developing ADHD (Smalley et al., 1998). Some other studies have found evidence for abnormalities of the dopamine-transporter gene (DAT-1) on chromosome 5 in children with especially severe forms of ADHD (Fone and Nutt, 2005; Hechtman 2005).

Index genes, responsible for synthesizing, metabolizing and releasing of dopamine have consistently been identified in the dopaminergic and serotonergic families that have been associated with ADHD (Biederman and Farone, 2005; Farone et al. 2005). Modest level stimulation of D1 family receptor is essential for the prefrontal cortex function, as well as optimal level of D4 and D5 receptor stimulation, to enhance working memory (Biederman et al. 2006). Lowering the deliverance and synthesizing dopamine is the physiologic implication of this process, similar way of therapeutic act of stimulants such as methylphenidate, as they are blocking the dopamine transporter (DAT) and increasing the stimulus intensity (Biederman, Safran, Seidman, Spencer and Wilens, 2006). An increase in DAT levels would be predicted to result in greater clearance of DA from synapse and hence to a relative deficiency of this neurotransmitter. There is, however, considerable debate as to whether increased DAT levels reported in imaging studies causes a reduction in synaptic DA or whether elevated DA triggers the rise in DAT levels (Fone and Nutt, 2005). Farone et al (2005) indicated that other gene have been associated with ADHD including mutations in the serotonin-1B receptor, serotonin transporter, dopamine ß-hydroxylase genes, mutations in the dopamine D4 and D5 receptors. All the mentioned studies concluded that these genes might increase the odds of having ADHD, but they do not directly cause it.

Genetic studies of ADHD also include twin, siblings, adoption and family studies, and outcome of them indicate that genetic factors play an important role in ADHD. A higher concordance has been found in monozygotic (identical) twins, compared with dizygotic (fraternal) ones. Heritability of ADHD has been estimated to be approximately 80% based on the twin studies (Farone et al., 2005). In addition, adoption studies indicate that biological relatives of children with ADHD, display higher rates of ADHD or associated disorders and perform worse on

standardized measures of attention than adoptive relatives. The general risk rate of ADHD in the first-degree relatives of children with ADHD varied between 20 to 25% while it is 4 to 5% in the normal control subjects (Hetchman, 2005). The fivefold increase in risk in first-degree relatives, implicates also strongly the genetic component.

The overall clinical effects of these gene abnormalities appear small, suggesting that nongenetic factors are also important. Some environmental risk factors have a direct biological impact: Although none of the imaging studies has found evidence of gross brain damage, investigators have assumed that fetal exposure to toxins or hypoxemia, may adversely affect cerebral dopamine-rich areas. These hypotheses support observations that hyperactivity and inattention are more common in children with fetal exposure to maternal smoking or alcohol, in children who have been exposed to high quantities of lead, and in children who had a lack of oxygen in the neonatal period (Hechtman, 2005; Pennington and Chhabildas 2003).

Psychosocial risk factors such as parental psychopathology and family conflicts also play a role in the etiology of ADHD. The study of Frank and Ben-Nun (1988) indicated more prenatal and perinatal problems in ADD with hyperactivity children than in ADD without hyperactivity ones; but no difference in psychiatric anamnesis of the families was evidenced. Assessment of the familial context of ADHD indicated that parents of children with ADHD are more prone to experienced stress, marital discordances. Additionally, they have more negative parenting practices and might demonstrate more psychopathology (Stefanos and Baron, 2007). In another study, the outcome was indicated that families of children with ADHD had significantly more problems in family functioning, even after the children with oppositional defiant disorder were excluded from the analyses (Kaplan, Crawford, Fisher & Dewey, 1998). A comparison study of parenting style between ADHD, emotionally disordered and normal children, via parents' reports indicated the higher level authoritarian parenting in children with ADHD (Lange et al., 2005).

Some investigators have noted that the parents of hyperactive children are often overintrusive and overcontrolling. It has therefore been suggested that such parental behavior is a possible risk factor for ADHD. However, it is also pointed out that, when children are treated with methylphenidate, there is a reduction in parental negativity and intrusiveness. This suggests that the observed overintrusive and overcontrolling behavior of the parent is a response to the child's behavior rather than the cause. More severe disruptive child behavior and lower parental sense of competence both predict the use of less effective parenting practices (Barkley et al., 1985; McLaughlin and Harrison, 2005, Stefanatos and Baron, 2007).

Güçlü and Erkıran (2005), have investigated personality pathologies in the parents of children with ADHD, and found that 11.9% of the mothers had histrionic personality disorder, 33.9% histrionic personality traits and 23.7% obsessive-compulsive personality disorder, significantly higher than in mothers of the comparison group of children with nocturnal enuresis. ADHD-group fathers' personality assessment rates are as follows: 22% histrionic personality traits, 16.1% anti-social personality disorder, 16.1% obsessive compulsive personality disorder, 9.3% histrionic personality disorder, all significantly higher than that of the enuresis-group fathers'.

The mechanisms when and how genes and environment work together to cause ADHD have not been worked out, but it is believed that, for some of these risk factors, interactions occur such that some environmental risk factors lead to ADHD only in genetically susceptible people (Barkley, DuPaul, McMurray, 1990).

1.3. ADHD and Comorbidity

ADHD is commonly associated with other psychiatric conditions. It has been estimated that more than half of the children with ADHD shows comorbidity with *at least one other* psychiatric condition such as depression, anxiety, oppositional defiant disorder (ODD), conduct disorder (CD) and substance use disorders. ADHD with ODD/CD may contribute to disorders of substance abuse in

adolescents and adults. Developmental disorders including mental retardation, ervasive developmental disorders such as autism and specific developmental disorders like learning disabilities are also often comorbid with ADHD. The type and rate of comorbidity vary depending on age, sex, and source of the patient population (Rucklidge and Tannock, 2002; Clark, Prior and Kinsellen, 2002; Brassett-Harknett and Butler, 2007; Biederman, Monuteaux, Kendrick, Klein and Faraone, 2007; Oosterlaan, Scheres and Sergeant, 2005). Co-morbid conditions complicate the diagnosis and treatment of ADHD; children with co-morbidities may benefit from additional psychosocial interventions (Hechtman, 2005; Stefanatos and Baron, 2007).

Erman, Tugay, Öncü and Urdavic (1999), in their retrospective study, investigated the comorbidity in Canadian children with the diagnosis of ADHD. The results indicated that 29.9% of the subjects did not show any comorbidity, whereas 35% had one comorbid psychiatric disorder, 25.5% of subjects had two and 8% of subjects three comorbid disorders. Concerning sex difference, the most comorbid disorder in boys was ODD (62.3%), followed by CD (30.2%), communication disorders (11.3%), mood disorders (7.5%), and anxiety disorders (6.5%). In girls, the most comorbid disorders were classified as ODD (54.8%), CD (22.6%), mood disorders (12.9%), communication disorders (9.7%) and anxiety disorders (6.5%). No significant difference of sex was observed between groups in accordance to the prevalence rate of comorbid disorders.

Different subtypes of ADHD have differing types and degrees of comorbidity. Cognitive and language related disorders and internalizing problems are mainly been found associated with inattention (ADHD-I) symptoms, rather than with hyperactivity / impulsivity symptoms (Chhanbildas, Pennington and Willcutt, 2001; Willcutt, Pennington, Chhanbildas, Friedman and Alexander, 1999). In addition, ADHD-I children appear to have a greater co-occurrence of learning problems, comorbid mood disorders such as depression or bipolar disorders (Farone, Biederman, Weber and Russell, 1998; Biederman et. al., 2006).

Mood disorders coexist with ADHD to a high degree. Major depression, dysthymia (mild chronic depression), and bipolar disorder are found at rates far beyond expectancy in the ADHD population. Biederman, Newcorn, and Sprich (1991) pointed out that the coexistence rate of depressive spectrum with ADHD was found 15 to 75% in the various studies.

According to Homer et al. (2000), coexistence of ADHD with mood disorders (depression and dysthymia) is 18%. Children with juvenile onset bipolar disorder appear to have ADHD and cyclic mood disorder concomitantly. The mood cycling can be very rapid. Thus, children with extreme behavior problems, irritability, and hyperactivity need assessment of both mood disorder and ADHD. The association between ADHD and mood disorders is likely due to related, but not identical genes (Lovecky, 2004).

Coexistence of ADHD and anxiety disorders was estimated about 25%, and of ADHD and learning disabilities 12% to 60%. (Hechtman, 2005; Stefanatos and Baron, 2007). The diagnosis of OCD and ADHD overlapped by 6 to 33% (Lovecky, 2004). Tourette syndrome has a high rate of coexistence with ADHD. Most studies have found that between 25 and 85% of children with Tourette syndrome also have ADHD. Often the very early signs of Tourette syndrome belong to the area of ADHD symptoms. Vice versa, if the cardinal symptoms of the Tourette syndrome, which are the tics appear to be present in children with ADHD, they need to be assessed for Tourette syndrome (Lovecky, 2004).

Children with ADHD-C type have higher incidence of behavior problems, oppositional defiant disorders, conduct problems, poor family- and peer-relations, and early substance use, and are more frequently referred for psychological intervention. For ADHD-C type, comorbidity rate of ODD and CD was reported as high as 40% to 65% (Barkley, 1990; Biederman et al., 2006). According to Homer et al. (2000), ADHD coexists with ODD and CD in ratios of 35% and 26% respectively. The largest body of literature concerning ADHD-comorbidity is on ODD and CD (Biederman, Newcorn and Sprich, 1991; Hechtman, 2005, Lovecky 2004), so it was thought that these disorders should be viewed closely. The

diagnostic features of CD include “a repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate social norms or rules are violated” (APA, 2000). The less severe condition of ODD is displaying persistent symptoms of “negativistic, defiant, disobedient, and hostile behaviors toward authority figures” (APA, 2000). This behavior pattern is present at home, school, and in social settings, with frequently losing of temper, arguing with adults, defying actively or refusing to comply with adults' requests or rules. These children often deliberately annoy or tease people, blame others for their own mistakes or misbehavior, are often touchy or easily annoyed by others, are often angry and resentful, spiteful or vindictive. These disturbances cause clinically significant impairment in social, academic, or occupational functioning (DSM IV-TR: APA, 2000). A high percentage of children referred in clinic samples with ADHD also have ODD, up to 80%. Boys are found three times more diagnosed on ODD than girls.

As mentioned above, ODD is quite prevalent in children with ADHD Combined Type. About half of them may progress on to the more serious conduct disorder. (Lovecky 2004). CD is a very grave behavioral childhood disorder with a repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate societal norms or rules are violated, as manifested by a) aggression to people and animals, b) destruction of property, c) deceitfulness or theft and d) serious violations of rules. The disturbance in behavior causes clinically significant impairment in social, academic, or occupational functioning. CD is seen as a possible risk factor for antisocial activities, illegal drug possessions, use and sale as well as being arrested in young adulthood (Babinski, Hartsough and Lambert, 1999; Barkley, Fisher, Smallish and Fletcher, 2004). Results of a longitudinal study in children with ADHD indicated that diagnosis of CD was usually comorbid with ODD, while in the absence of CD, ODD did not necessarily progress to conduct disorder, nor did it share the poor outcome of CD (Barkley, Fisher, Smallish and Fletcher, 2004).

Comparison of behavioral problems, peer relations and school achievement of children with ADHD+ODD, ADHD and control group indicated that ADHD+ODD children had higher CBCL aggressive behavior score than ADHD and control group. In addition anxiety/depression, social problems, and delinquent behavior subscale scores of CBCL were significantly higher for ADHD and ADHD+ODD groups. There was also a more problematic relationship with peers and lower school achievement in these groups compared to the control group in a recent study of Çakaloz, Akay and Günay (2007).

Kılıç and Şener (2005), was compared the family functioning and current psychiatric disorders in the parents of children with ADHD, and parents of children with ADHD+ODD / CD. The sample consists of 92 children, aged between 6-11 years old. Sixty-four (69.9%) of the sample was diagnosed with ADHD, and 28 (30.4%) of sample was diagnosed with ADHD+ODD / CD. The families of children with ADHD+ODD / CD had higher scores on unhealthy functioning in the Roles and Behavior Control subscales of the Family Assessment Device (FAD). In addition, maternal depression and paternal drinking problems were high in the ADHD+ODD / CD group.

1.4. ADHD and Executive Functions (EF)

While the accurate etiology of ADHD remains unclear, in the most recent neuropsychological theories, ADHD is postulated to arise from a deficit in executive functioning (EF) as being the main characteristic of the disorder (Willcutt, Doyle, Nigg, Farone and Pennington, 2005; Barkley, 1997). The term "executive function" refers to the higher cognitive processes that control conscious and voluntary self-regulation and goal directed behavior such as response inhibition, planning, abstract thinking, working memory, organizing, attention shifting, verbal fluency, self-monitoring, holding a mental representation of the task through working memory and maintaining an appropriate problem solving set to attain a future goal as well as physiological arousal, motor control, emotion

regulation and prosocial behavior (Rhodes and Kelly, 2005; Trannel, Anderson and Benton, 1997; Welsh and Pennington, 1988; Biederman et al., 2006). Such cognitive capacities are at the most supraordinate level in cognitive hierarchy (Trannel, Anderson and Benton, 1997).

The rise and ripening of the executive functions is a pivotal cognitive-developmental achievement in the early childhood period. There is continuity in self-regulatory development from the birth on. In the first year, infants notice patterns in the environment and spontaneously form categories of events and event sequences. They get increasingly able to detect predictive relations and take pleasure in their own ability to be the authors of anticipated events. Therefore, the emerging cognitive control is elaborated in more goal-directed behavior and in monitoring progress and frustration on the road toward goal-achievement.

Studies that are testing developmental paths of EF, suggest that children at 5-12 months could present rudiments of inhibition, and by the age of 7 normal children can conceptually understand when to inhibit responses; however this may not always turn out as a successful performance (Brocki and Bohlin, 2006; Dowsett and Livesey, 2000). Fully matured inhibitory control is obtained between age of 8 and 12 (Lezak, 1983; Trannel, Anderson and Benton, 1994). On the other hand, executive abilities of fluency and complex planning would attain adult levels later in adolescence (Lezak, Howieson and Loring, 2004; Welsh and Pennington, 1988).

Lezak, Howieson and Loring (2004) describe EF as an "ability to respond in an adaptive manner to novel situations" and as "the basis of many cognitive, emotional, and social skills" (pp. 611). The EF can be conceptualized as having four components: (1) Volition refers to the capacity for intentional behavior. (2) Planning is necessary for carry out an intention or to achieve a goal. Conceiving alternatives, weighing and making choices, and entertaining sequential and hierarchical ideas are necessary for getting a conceptual framework or structure that will give direction for carrying out a plan. In addition, good impulse control, reasonably intact memory functions, and especially good capacity of sustained attention are also necessary. (3) Purposive action requires person to initiate,

maintain, switch, and stop sequences of complex behavior in an orderly, integrated manner. (4) Effective performance needs performer's ability to self monitoring, self-correcting, self regulating the intensity, and tempo for an effective performance. All these four EF components are necessary for appropriate, socially responsible, and effectively self-serving social contact with others (Lezak, Howieson and Loring, 2004).

One of the most influential, and most comprehensive models of ADHD is the hybrid model of ADHD presented by Barkley (1997). According to the hybrid model, ADHD is seen primarily as a deficit in executive inhibition referring to inhibition of initial proponent response to an event, stopping of an ongoing response that permits a delay in the immediate respond, and interference control. The hybrid model mainly assumes that dysfunctional response inhibition and impaired working memory are concerned as core deficits of executive functioning in ADHD, and indicate that the development of adequate inhibition is first and essential step for the development of the four domains of EF: working memory, self regulation, internalization of speech and reconstitution.

Barkley's model has a hierarchical organization with inhibition at the top of the hierarchy and the four executive functions at the lower level (Berlin, 2003). As presented in Barkley's hybrid model, these functions all together would be able to account for the deficits associated with ADHD, and leading to problems in the Motor Control / Fluency / Syntax area (Figure 2). A more detailed description of the four executive functions follows (Barkley, 1997):

Working memory

It refers to the capacity of maintaining information in mind and using it for guiding immediate behavior in the absence of informative external cues. As it was mentioned above, poor behavioral inhibition in ADHD would lead to secondary deficits in working memory and its sub-functions. Some of these deficits are, being more influenced by context and less controlled by internally represented information, as well as more influenced by immediate events rather than distant

time, having difficulty to recall and hold information in mind about the past (hindsight), and difficulty in making plans about the future (forethought and planning). In addition, children with ADHD would have less ability to persist goal-directed behavior.

Working memory has often been assessed in neuropsychological research with the following tasks: Oral repetition of digit span (especially digit backward), mental arithmetic, such as serial addition, WISC-R Freedom from Distractibility factor, composed of digit span, mental arithmetic, and coding. Children with ADHD would have lower scores than children without.

Self regulation

Self regulation of arousal, affect and motivation have connection with inhibition. Children with ADHD would have following deficits connected with poor self-regulation; greater emotional reactivity to immediate events, difficulty to take into consideration of others' emotions, incapacity to sustain the arousal and drive towards the goal, greater dependence on external sources affecting drive, motivation, and arousal. Children with ADHD are believed to have poor emotional control and they would not be able to delay their immediate reaction in favor of an appropriate situational behavior. Tasks basing on reinforcement and reward are to use to assess self-regulation in children with ADHD.

Internalization of speech (verbal working memory)

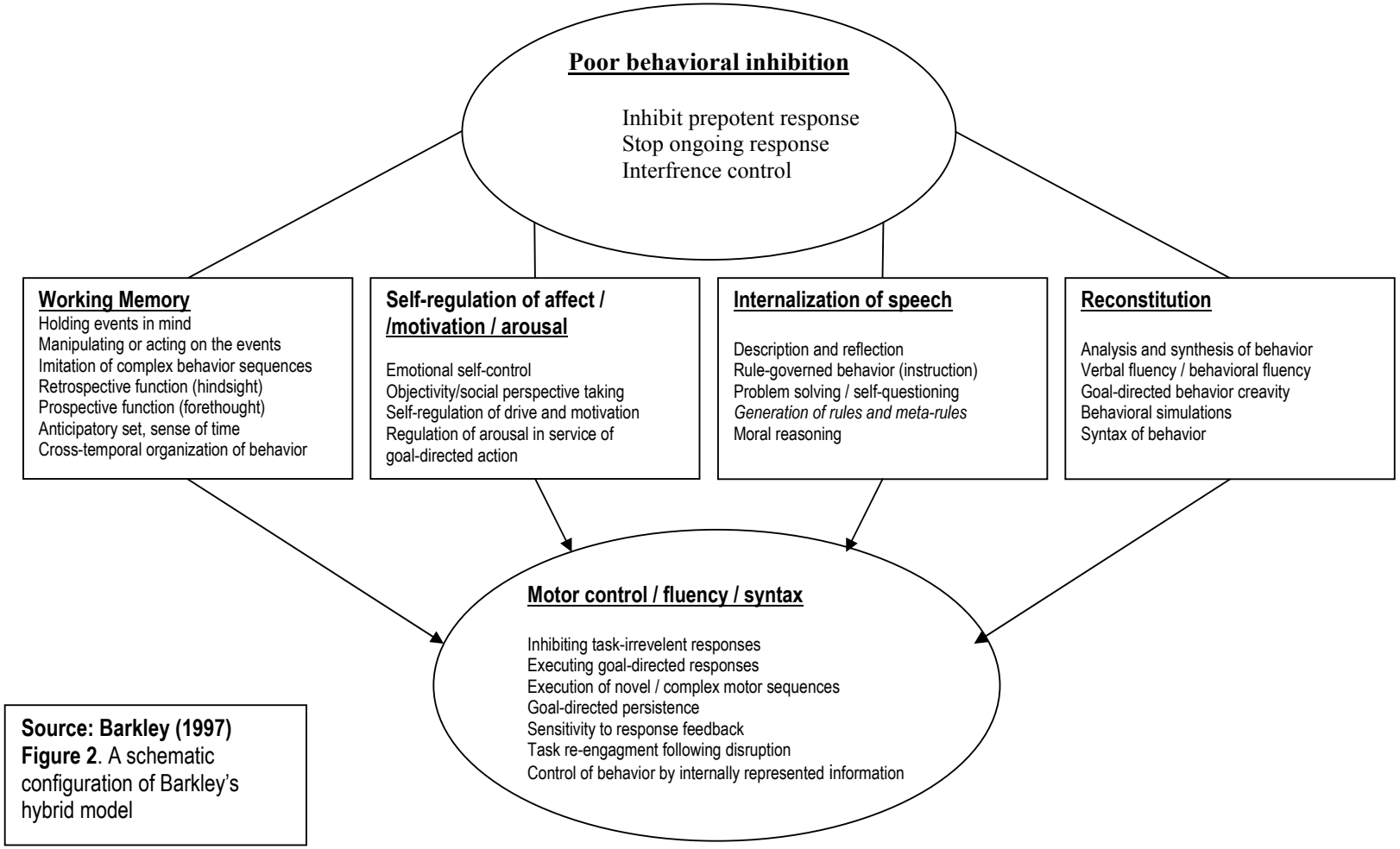
The third executive function of Barkley's is internalization of speech (verbal working memory), which is mediating behavior through learning history, internalized rules, and active problem solving. Children with ADHD are less compliant with directions and commands given by, less able to restrict their behavior in accordance with experimenter's instructions, less able to resist forbidden temptations, and they have difficulty for following the rules. Because delay of rule-governed behaviors is persistent in children with ADHD, they are less adequate at problem solving, and are less likely to use organizational rules and

strategies in memory tasks. Reaction time or continuous performance tasks would assess the effect of rule governance on behavior in children with ADHD.

Reconstitution

The fourth one is reconstitution representing two interrelated activities that are analysis and synthesis, which are enabling to separate the units of behavioral sequences and recombine them in creative ways into new sequences of behavior either verbally or non-verbally. Reconstitution is also essential in nonverbal behavior and in problem solving tasks requiring complex and novel motor sequences or goal-directed behavioral creativity. Children with ADHD would have greater difficulties with tasks, settings, and interpersonal interactions. Tests of verbal fluency, creativity during free play, performance on nonverbal, figural creativity tasks would reflect the reconstitution.

Both Barkley's (1997) and Lezak, Howieson, and Loring's (2004) point of view in EF mainly concerns individuals' appropriate goal directed, planned and self-regulated behavior while interacting with others. Barkley (1997) states that children with ADHD-I type may represent a separate disorder, handicapped with more problems in selective attention, sluggishness, and memory retrieval as well as academic difficulties in mathematics, language, and reading. On the other hand, children with ADHD-C type are characterized having poor behavioral inhibition; they have problems with inhibition of proponent responses which limits control of behavior, poor planning and anticipation, reduced sensitivity to errors, poor organizational capacity, impaired verbal problem solving and self-directed speech, poor role-governed behavior, and poor self regulation (Barkley, 1997). Under the light of this assumption, the author postulated a model of ADHD in which only ADHD-C and ADHD-H, but not ADHD-I are associated with executive function deficits (see Figure 2) (Barkley, 1997; Tannock, 2003).



Source: Barkley (1997)
Figure 2. A schematic configuration of Barkley's hybrid model

Geurts, Verte, Oosterlaan, Roeyers and Sergeant (2005) investigated the EF hypothesis of Barkley (1997), proposing that children with ADHD-C would display pervasive EF deficits. They compared three groups (ADHD-I, ADHD-C and Normal Control); each group was build of 16 subjects that were all matched on age, IQ and the presence of oppositional defiant disorder (ODD) or conduct disorder (CD). Groups were compared on five major domains of EF, which are response inhibition, visual working memory, planning, cognitive flexibility, and verbal fluency. The outcome of study did not support Barkley's EF model of ADHD, firstly, ADHD-C showed difficulties in two areas of inhibition; that were inhibiting proponent response and inhibiting an ongoing response. No significant difference was observed between ADHD-C and normal controls for general executive dysfunction, except one of the cognitive flexibility measures. Secondly, the study failed to find deficits in children with ADHD on working memory measured by the Self-Order Pointing Task, cognitive flexibility measured with the Wisconsin Card Sorting Test, planning measured by the Tower of London and verbal fluency measured by Semantic Categories (animals and food) Task as well as Words Beginning with the Letters K and M Task (Geurts, Verte, Oosterlaan, Roeyers and Sergant, 2005).

Pennington and Ozonoff (1996) reviewed published previous studies, in which EF tasks were applied to children with ADHD. In their meta-analysis, they found that 15 out of 18 studies displayed significant difference between ADHD subjects and controls on one or more EF measures. They concluded that the consistently impaired domain of EF in children with ADHD was inhibition, and on the contrary, the less likely impaired EF domains were set shifting and working memory (Pennington and Chhanbildas, 2003). In addition, Willcutt et al. (2005) conducted a meta-analysis of 83 studies that administered EF measures to subjects with ADHD and without ADHD. Outcome of the meta-analysis indicated that several domains of EF weaknesses were associated with ADHD. Effect sizes for all measures fell in the medium range (.46- .69), but the most consistent effects were observed in measures of inhibition, vigilance, spatial working memory, and some

measures of planning. On the other hand, EF weaknesses were observed in both clinic-referred and community samples and could not be fully explained by group differences in intelligence, academic achievement or symptoms of comorbid disturbances. Children with ADHD were generally unimpaired on measures of verbal memory, verbal processes or visuospatial processing (Pennington and Chhabildas, 2003).

Biederman, Petty et al. (2006) examined the functional impact of psychometrically defined deficits of executive functioning by comparing four study groups of adults: 'normal' comparison subjects (n = 122), comparison subjects with deficits of executive functioning (n = 23), subjects with ADHD (n = 147) without deficits of executive functioning, and subjects with ADHD and deficits of executive functioning (n = 66). Outcome of the study indicated that ADHD subjects had higher executive function deficits than comparison subjects. Even though, deficits of executive functioning alone cause impairment in educational outcomes, adults with ADHD and comorbid executive functioning deficits exhibited poorest educational outcome as well as lower socio-economic status, poorest occupational attainments, and poorest use of leisure times. In addition, rate of automobile accident was higher in this group compared to the pure ADHD group and comparison group.

Even though executive function deficits prevalent in children/adults with ADHD, variability between studies and within ADHD samples indicates that normal executive functioning can not be used or make rule out diagnosis of ADHD (Biederman, 2006; Sergeant, Geurts and Oosterland, 2002). In other words, outcome of EF tests can not be used as diagnostic criteria for ADHD.

1.5. Executive Functions and Prefrontal Cortex

Neuropsychological studies implicate the connection between ADHD symptoms and frontal lesions. According to Squire et al. (2003), symptoms of ADHD involve dysfunction of the prefrontal cortex and its cortical and subcortical connections. Children with frontal lobe lesions have a tendency to abnormalities of

impulse control, as well as abnormalities in motor activity and attention span (Frank, 1996). Diagnosis criteria of "inattention" as a symptom of ADHD has a connection with attentional abilities of the prefrontal cortex (PFC) such as difficulty sustaining attention or organizing, distractibility and forgetfulness: meanwhile, symptoms of "hyperactivity/impulsivity" such as difficulty awaiting turn and inhibition have a connection with PFC deficits. The PFC controls attention through its projections into the parietal and temporal cortexes, while it controls motor responses through its projections into the motor cortex and striatum (Squire, Bloom, Mc Connell, Roberts, Spitzer and Zigmond, 2003; Willcut, Doyle, Nigg, Faraone, Pennington, 2005). Structural and functional imaging studies indicate that the PFC-striatal-cerebellar circuits appear to be impaired in patients with ADHD, with smaller right-sided PFC regions, decreases in the size of striatum and cerebellar vermis, a region that have regulatory influences over dopaminergic (DA) and noradrenergic (NE) cells. DA and NE have critical influences on PFC-striatal circuits for maintaining PFC cognitive functions and regulation of behavior and attention. Stimulants (e.g. methylphenidate) are in use as a medication of ADHD in the aim of reducing symptoms of inattention and impulsivity by optimizing the neurochemical environment in the PFC and in striatum by increasing NE and DA release and/or blocking monoamine reuptake (Squire, Bloom, Mc Connell, Roberts, Spitzer and Zigmond, 2003).

The frontal cortex and its subcortical connections have been suggested to serve as the major neurological underpinnings for EF (Grabowski, Anderson and Cooper, 2002; Lezak, 1983; Trannel, Anderson and Benton, 1997). The classical case of Phineas Cage was an important example for understanding importance and effect of frontal cortex in EFs. Phineas Cage was a railway-worker and had extensive left and some right frontal lobe damage as a result of tamping iron passing through his head. Although Phineas Cage did not manifest obvious defects in basic intellectual cognitive capacities, he had post-morbid personality change, becoming capricious, unpredictable and obstinate given to poor judgment and fool language, and lacking consideration of others. Case of Phineas Cage indicated that

the frontal lobe was linked to social conduct, judgment and personality (Trannel, Anderson and Benton, 1997).

Many of the behavioral problems arising from impaired executive functioning such as defective capacity for self-control or self direction, difficulty in making shifts in attention or in ongoing behavior, impulsivity, deterioration in personal cleaning would be easily observed by any person around. On the other hand some of the EF defects might not be so obvious, such as impaired capacity to initiate activity, decreased or absent motivation, defects in planning and carrying out goal directed behavior. People who have these kinds of control defects are often misunderstood and seen as being lazy or spoiled. In addition, it might be difficult to assess impairment of EF (mainly control-defects) in these people via ordinary neurological or psychological assessment (Lezak, 1983).

Impairment of EF is usually a sign of dysfunction in the prefrontal cortex. In addition, damage to frontal-striatal networks and temporoparietal regions, particularly on the right, might cause the deficits in EF (Grabowski, Anderson and Cooper, 2002). When EF impairments result from damage to non-prefrontal regions, dysfunction tends to be relatively mild and appears to be widespread cognitive deficits. On the other hand, severe EF impairments always point to dysfunctions in the prefrontal cortex (Grabowski, Anderson and Cooper, 2002). Failures of perception and attention related to frontal lobe dysfunction are attributable to difficulties in planning, motor set, short-term memory, temporal ordering and control of interference. Patients with frontal lobe disease additionally exhibit inappropriate cheerfulness, lack of concern, making bad jokes, sarcasm, latent hostility, outright aggression, bad temper, and personality change. However, not all patients show such characteristics, and the effects are variable and multiply determined. Executive capacities are evidenced very early in development, in the first few years of life. Considerable maturation of EF takes place in the age range of 3-12, and especially in the years between 6 and 12 (Trannel, Anderson and Benton, 1997).

1.6. Intelligence, EF and ADHD

Wechsler intelligence scales for children (WISC-R, WISC III, WISC IV) are used as intelligence test for determining subject's intelligence quotient, but also as a diagnostic tool for assessing neurodevelopmental / neuropsychological problems in children such as ADHD, learning disorders (LD) (Nyden, Billstedd, Hjelmquist, and Gillberg, 2001). As mentioned in the method section, WISC-R consists of 12 subtests: Six of them assess verbal IQ, and another six assess performance IQ. The twelve subtests overall give the full scale IQ.

Watkins, Kush and Glutting (1997) reported that Kaufman in 1975 produced Freedom from Distractibility (FD) factor via factor analysis of WISC-R standardization sample. FD was composed of WISC-R arithmetic, coding and digit span subtests, for measuring short-term and auditory memory. Since than FD was used in various studies for discriminating children with ADHD, LD, Writing Disorders with an assumption of getting lower scores in these sample groups than in the normal community samples. Outcomes were controversial. In the aim to enhance the predictive differentiating power of FD factor, the researchers added the information subtest to the FD triad to create ACID profile. Both of them are used to discriminate children with ADHD and LD (Watkins, Kush and Glutting, 1997).

Two different types of intelligence are in concern recently: Fluid intelligence (Gf) and crystallized intelligence (Gc). The first one (Gf) reflects higher mental abilities, including reasoning, problem solving through basic reasoning ability, and is not influenced by formal schooling or culture. The later one (Gc) reflects knowledge acquired partly through Gf, in other words problem solving, education, culture and other experiences. Concerning WISC Intelligence Tests, it is assumed that arithmetic, block design, and objects assembly are seen as a good measure of Gf, while information, vocabulary, and comprehension are concerned as a good measure of Gc (Nyden, Billstedd, Hjelmquist, and Gillberg, 2001).

Accepting the validity of the premises, a) that the major cognitive deficit in ADHD is impaired executive functions (EF), and b) that EFs are the primary

substrate for the general intelligence factor, obtained when batteries of mental tests are factor analyzed, would foster the conclusion, that children with ADHD should tend to have lower Intelligence Quotient (IQ) than children in the general population. Previous researches suggested that, children with ADHD have an IQ about 9 point lower than typically developing peers (Antshel, Phillips, Gordon, Barkley and Faraone, 2006).

EF deficits are not necessarily accompanied by corresponding deficits in psychometric IQ. In terms of intellectual skills, the ADHD-population characterized by EF dysfunction falls along a normal distribution. And children with ADHD, do not have IQ scores that are lower, on average, than children in the test standardization populations. Human frontal lobe patients often have clear EF deficits, but IQ (a next-best estimate of general intelligence) may be preserved. These findings cast serious doubt on the plausibility of the link between EF and IQ. Clarifying the distinction between psychometric general intelligence and EF can be important for understanding the differences between practical and psychometric intelligence. The researchers emphasize the distinction between elementary components, such as those composing EF, and global problem-solving capacity, that is the general intelligence, as only the former seems to be affected by ADHD (Crinella and Yu, 2000; Schuck and Crinella, 2005). The major problem for subjects with ADHD lies so, in the non-efficient use of intellectual skills. The weak attention and self-control, poor goal oriented flexibility as well as the impossibility to delay actions may interfere with the intellectual potentialities, especially on tasks requiring inhibition.

Some other research in the area does not support the EF theory of ADHD, and consequently refuse the link between IQ and ADHD. When intelligence was controlled for, no significant relationship between parent and teacher ratings of ADHD symptoms and performance on EF tasks could be found in these studies. These results cast also doubt on whether EF deficits and/or frontostriatal networks conribute etiologically to the major behavioral manifestations of ADHD (Jonsdottir et al, 2006, Marks et al. 2005).

There is a general tendency to assume that ADHD does not cause significantly lowered intellectual functioning, but vice versa, the contrary of this assumption is less clear. In other words, whether significant lowered intellectual functioning causes ADHD symptoms or not is not clear (Antshel, Phillips, Gordon, Barkley and Faraone, 2006). Children with significantly lowered intellectual functioning display symptoms of inattention, being overactive and/or impulsive in general. Therefore, low IQ was a rule out for ADHD in earlier editions of DSM.

If executive dysfunction is a distinguishing characteristic of ADHD, the expectation would be to find greater executive dysfunction in children with ADHD regardless of intelligence level (Ansthel, Phillips, Gordon, Barkley and Faraone, 2006). Evaluations of relationship between EF and ADHD were generally excluding children who had low intelligence level (IQ below 80). Thus, EF deficits have been attributed to average IQ children with ADHD (Barkley, 1997; Riccio, Homack, Jarratt, Wolfe, 2006; Shallice et al. 2002). EF of ADHD children with low intelligence level (IQ below 70) has not been assessed (Ansthel, Phillips, Gordon, Barkley and Faraone, 2006). Mahone et al (2002) aimed to measure whether selected EF measures are distinguishing children with ADHD from control group at average and above average (superior) IQ levels. The outcome indicated that IQ is a powerful moderator variable for understanding the impact of ADHD, and at average IQ, the prefrontal component of motor control and fluency may be insufficient to meet in demands, while at above average or superior IQ, the prefrontal component may be more intact. Another study with the aim of assessing the relation between intelligence functions and EF measures in normal children indicated that Verbal IQ and Full Scale IQ significantly correlated with verbal fluency tests and Wisconsin Card Sorting Test (WCST) perseverative errors, and the outcome of study assumed that traditional intelligence tests do not appropriately evaluate EFs (Ardila, Pineda and Rosselli, 2000).

Biederman, Petty et al. (2006), in their comparison study between four adult groups; ADHD, ADHD with EF deficit, only EF deficit group and comparison group, indicated that EF deficit groups' IQ levels were significantly

lower than that of the non-affected comparison group. As it was concluded by the authors, deficits of EF have an effect on IQ. Considering that ADHD alone might have an effect on the development of intelligence, the combination of ADHD with deficits of EF should have a considerable negative impact on the IQ levels of adults.

Another concern with intelligence level and ADHD is assessing the difference of WISC-R subtests in children with ADHD. It was evidenced that children with ADHD displayed poorer performance on subtest of coding and block design ((Rucklidge and Tannock, 2001). In their study, Bakar, Soysal, Kiriş, Şahin and Karakaş (2005) analyzed WISC-R scores of 105 ADHD patients and 90 matched control subjects. Even though all verbal and performance subtest scores of ADHD children were lower than that of the control group, only scores of information, similarities, arithmetic, block designs and coding were significantly lower than control group.

In summary, there was a relationship between IQ, EF tests and ADHD according to the overview above. Children with ADHD had lower scores in Distractibility from Freedom function, and ACID profile than children without ADHD. In addition, ADHD children with average or above average IQ did not display EF deficits. On the other hand, both ADHD and EF had a negative effect on IQ.

1.7. EF Tests / Tasks and ADHD

Literature review indicates that neuropsychological tests presuming to assess executive functions have found difference between children with ADHD and control groups in some aspects (Sergeant, Geurts, Oosterlaan, 2002; Willcutt, Doyle, Nigg, Faraone, Pennington, 2005). Tests for assessing different aspects of EFs, like response inhibition, planning, working memory, set shifting or cognitive flexibility indicated that subjects with ADHD perform more poorly than control ones (Stefanatos and Baron, 2007). In the meta-analysis of Pennington and Ozonoff (1996), 18 published studies of EFs in ADHD is reviewed; 15 of them indicate

significant difference between ADHD subjects and controls on one or more EF measures. Total 40 out of 60 EF measure scores are significantly worse in the ADHD group (67%). In addition, the most consistently impaired domain of EF is inhibition, on the contrary set-shifting and working memory are less impaired in children with ADHD (Pennington and Chhanbildas, 2003).

Mainly five domains of executive functions are to assess through using various EF tests. Before giving a summary of the research results gathered via the EF tests, a description of assessing tools of five EF domains will be overwieved in Table 1, based on the study of Willcutt et al (2005). The more detailed description of EF tests will be presented in the method section.

Table 2. Description of EF Tasks

Domain of EF assessed	Task Name	Description of Task
Planning	Tower of London (ToL)	The task is demanding minimum number of moves required for the solution in each presenting problem
Response Inhibition	CPT Commisision Errors Stroop-Color Word Scores	Responding a sequence rather than the target sequence Naming the printing color word, inhibiting tendency to read
Working Memory	WISC- R Digits Backward Letter Fluency F-A-S	Measuring the repetition of 2 to 8 digits backward Naming as many words as possible given in the one minute time for each letter consequently
Vigilance	CPT Omission Errors WCST Perseverative Errors	Failure to respond target sequence Difficulty shifting new rule, continuing to sorting according to previously successful principle
Set-shifting	Trail Making Test- B	Connecting a series of numbers in ascending order while alternating between the two different colored numbers

CPT: Continuous Performance Test, **WISC-R**: Wechsler Intelligence Scale for Children- Revised, **WCST**: Wisconsin Card Sorting Test

Research results of various studies aiming to assess EF in ADHD children with different neuropsychological or EF measurements will be overviewed: As reported in the manual of ToL, children with ADHD use more moves, take longer to complete problems, and have more rule violations than normal controls (Culbertson, Zillmer, 2000). On the other hand, Pasini et al. (2007) did not find any

statistical difference on the number of solved problems, and on the time of planning.

Concerning Wisconsin Card Sorting Test, 17 out of 26 studies using the WCST found significant differences between ADHD and normal controls (Sergeant, Geurts, and Oosterlaan, 2002). Children with ADHD complete fewer categories than normal controls (Doyle et al, 2000), and showed more deficiency in flexibility and perseverative errors than high functioning autistic and control groups (Tsuchia et al 2005).

Grodzinsky and Barkley (1999) found that the F-A-S (K-A-S) task to have good positive predictive power, correctly identifying 90% of children with ADHD, in a study of frequently used neuropsychological tests for assisting the diagnostic process of ADHD. On the contrary, 68% of children with ADHD scored in the normal range, indicating low sensitivity. In another comprehensive review, only half of the studies predict significant differences between ADHD and control groups. This outcome suggests questionable clinical utility of the F-A-S (Rapport et.al, 2000)

Fisher, Barkley, Edelbrock and Smalish (1990) found that the ADHD group committed more omission and commission errors on the CPT than normal controls. The CPT was found to discriminate ADHD children from normal controls particularly for commission errors (Barkley, 1991). On the other hand, according to Grodzinsky and Barkley (1999), CPT is not sufficiently sensitive to presence of ADHD in most children with false negative rates of 60% for CPT number of correct responses and commission errors.

According to Denckla (2002), Go/No-Go task did not yield results of failure to inhibit on infrequent “no-go” trails but indicated excessively variable reaction times on correct “go” trails as well as elevated anticipatory responses for ADHD.

Trail Making Test Part-B is a commonly used test of prefrontal functioning and is considered as measure of the ability to shift flexibly the course of an ongoing activity (Lezak, 2004). On the other hand, according to Grodzinsky and Barkley (1999), trail making test showed relatively low rates of positive predictive power,

indicating that ADHD and control groups were not significantly different in their frequency of subjects having abnormal and normal scores.

1.8. Aim of Study and Hypothesis

The aim of the present study is;

Firstly to investigate and assess the evaluation differences of WISC-R subtests and Verbal (VIQ), Performance (PIQ), Full Scale IQ as well as Child Behavior Check List (CBCL) Problem Behavior Scores (Internalizing, Externalizing, Total Problem) and Syndrome Scales (Withdrawn, Somatic Complaints, Anxious/Depressed, Social Problems, Thought Problems, Attention Problems, Delinquent Behavior, Aggressive Behavior) between ADHD subtype groups (ADHD-I, ADHD-C and ADHD-Comorbid) and control group.

Secondly, to assess the relationship of EF measures with Conner's Parental Rating (CPR) and Teacher Rating (CTR) Scale Inattentiveness and Hyperactivity Scores, WISC-R VIQ, PIQ and FSIQ, CBCL Problem Behavior Scores for each study group (ADHD-I, ADHD-C, ADHD-Comorbid and Control groups) separately.

Thirdly, to evaluate specificity of EF measures such as inhibition, planning, working memory, set shifting in ADHD children via comparison of ADHD subtype groups (ADHD-I, ADHD-C and ADHD-Comorbid) and normal control group.

Fourthly, to evaluate the discriminating power of different EF measures of inhibition, planning, working memory, set shifting, between study groups.

Based on the focus of this study, the following hypotheses are posited:

1. Hypothesis I: Children with ADHD (ADHD-I, ADHD-C and ADHD-Comorbid) significantly differ from normal controls on measure of Conner's Parental and Teacher Rating Scores of Inattentiveness and Hyperactivity.
2. Hypothesis II: CBCL Problem Behavior and Syndrome Scales' scores of ADHD children would be significantly different in accordance to their subgroups, and CBCL scores of ADHD-I,

ADHD-C and ADHD-Comorbid groups would be significantly worse than those in the control group.

3. Hypothesis III: Children with ADHD (ADHD-I, ADHD-C and ADHD-Comorbid) significantly differ from normal controls on measure of WISC-R VIQ and PIQ, and WISC-R subtest scores.
4. Hypothesis IV: There would be significant correlations between inattentiveness and hyperactivity scores of CTR, and CTR scales, VIQ, PIQ, Full Scale IQ of WISC-R, Internalizing, Externalizing, Total Problem Score of CBCL and EF measurements in each group separately.
5. Hypothesis V: Children with ADHD (ADHD-I, ADHD-C and ADHD-Comorbid) significantly differ from normal controls on measure of EF measures such as inhibition, working memory, set-shifting, planning.
6. Hypothesis VI: EF measures would significantly discriminate different subgroups of ADHD (ADHD-I, ADHD-C and ADHD-Comorbid), and the Control group.

CHAPTER 2

METHOD

2.1. Participants

Participants consist of 147 children. Total of 111 children were assigned into the ADHD groups of the study. Thirty seven children (5 girl and 32 boys) were assigned into the ADHD-Inattentive group, thirty seven children (6 girls and 31 boys) were assigned into the ADHD-Combined group; and thirty seven children (4 girls and 33 boys) were classified as ADHD-Comorbide group (ADHD-C with Oppositional Defiant Disorder consists of 4 girls and 31 boys, and/or Conduct Disorders consists of 2 boys). Thirty six children (6 girls and 30 boys; age range: 7-12) were assigned as control group by matching with the ADHD groups according to the WISC-R Full Scale IQ score, sex and age. The control group children were recruited from local public elementary schools. All children in the ADHD group fulfilled the criteria for ADHD-Inattentive subtype (ADHD-I), ADHD- Combined subtype (ADHD-C), and ADHD- Combined subtype with comorbide of Oppositional Defiant Disorder and /or Conduct Disorder (ADHD- Comorbide) respectively, according the $4^{th\ revised}$ edition of the Diagnostic and Statistical Manual (DSM IV-TR).

An assessment sheet was prepared by the researcher in the aim of assessing the demographic characteristics of children, and filled with parents during the clinical interviewing. One way ANOVA was carried out to analyze continuous demographic variables, and outcome was presented in Table 3. Concerning to family income, there was not any significant difference between the groups, same as in the mother's and father's age groupings. On the other hand, a significant difference was observed between ADHD-Comorbid and Control groups concerning the mother's education [$F\ (3,143) = 3.33$, $MS_{error} = 38.53$, $p < .02$], indicating that

education level of the Control groups' mothers is higher than that of the ADHD-I, ADHD-C, and ADHD-Comorbid group. Concerning the father's education level, ADHD-Comorbid group showed significantly lower levels than the ADHD-I and Control groups [F (3,143) = 4.34, MS_{error} = 51.34, p<.001].

Table 3. **Distribution of** Subjects' **Age,** Parents Age, and Education, and Family Income

	ADHD-I	**ADHD-C**	**ADHD-Comor.**	**Control**	**F Value**
	(n=37)	**(n=37)**	**(n=37)**	**(n=36)**	
	M (SD)	M (SD)	M (SD)	M (SD)	
Subjects Age	9.89 (1.70)	8.95 (1.60)	9.14 (1.81)	9.33 (1.67)	2.15
Mothers Age	35.95 (4,39)	34.32 (4.82)	33.97 (5.52)	36.97 (5.63)	2.75
Fathers Age	39,21 (4,52)	38.45 (6.07)	38.83 (5.67)	41.33 (5.83)	1.94
Mothers Education	8.70a (3.54)	7.43a (3.43)	7.02a (3.29)	9.19b (3.32)	**3.33***
Fathers Education	9.46a (3.46)	8.46ab (3.62)	7.27b (3.09)	9.94a (3.70)	**4.25****
Family Income	1.61 (1.22)	1.45 (1.22)	1.25 (0.84)	1.51 (1.26)	0.69

**p<.01, *p<.05

In the aim of assessing behavioral disorders of all groups, Child Behavior Check List (CBCL) was given to parents. The outcome was reported in the results section. The mean scores of Conner's Rating Scales, the mean values of age, and the WISC-R mean scores were presented according group and sex distribution, in Table 4 and Table 5. The parents' and teachers' reports were not indicating any attention- or behavior-problem or learning disability for control group children.

Table 4. Descriptive Statistics for Conner's Parental and Teacher Rating Scales

	ADHD-I	ADHD-C	ADHD-Comorb.	Control
	M (SD)	M (SD)	M (SD)	M (SD)
CPRS	**(n=37)**	**(n=37)**	**(n=37)**	**(n=36)**
Inattentive	7.30 (2.18)	7.81 (2.59)	8.59 (3.33)	2.86 (2.38)
Hyperactive	4.76 (2.24)	8.46 (2.53)	8.57 (2.20)	3.11 (2.21)
CTRS				
Inattentive	11.30 (4.86)	8.30 (3.69)	12.70 (4.52)	3.08 (2.63)
Hyperactive	4.78 (3.04)	12.11 (3.75)	13.19 (4.78)	4.28 (3.57)

CPRS: Conner's Parent Rating Scale, **CTRS**: Conner's Teacher Rating Scale

Table 5. Descriptive Statistics for Verbal IQ, Performance IQ, Full Scale IQ of WISC-R by Gender and Groups

	ADHD-I	ADHD-C	ADHD-Comorb.	CONTROL
	M *(SD)*	M *(SD)*	M *(SD)*	M *(SD)*
WISC-R				
Female	**(n=5)**	**(n=6)**	**(n=4)**	**(n=6)**
VIQ	108.60 (10.76)	108.33 (7.94)	94.75 (5.38)	112.33 (14.09)
PIQ	107.00 (18.40)	109.00 (15.82)	96.50 (2.89)	114.83 (8.08)
FSIQ	109.00 (13.53)	109.67 (11.78)	95.00 (2.16)	114.67 (9.93)
Male	**(n=32)**	**(n=31)**	**(n=33)**	**(n=30)**
VIQ	102.60 (12.30)	101.94 (11.26)	102.94 (12.76)	108.87 (10.52)
PIQ	103.31 (11.27)	102.77 (12.76)	102.97 (12.58)	103.77 (13.44)
FSIQ	102.72 (10.83)	102.45 (11.18)	103.21 (11.75)	105.61 (13.28)
Total	**(n=37)**	**(n=37)**	**(n=37)**	**(n=37)**
VIQ	102.95 (12.81)	102.97 (10.96)	102.05 (12.41)	109.44 (11.04)
PIQ	103.81 (12.81)	103.78 (13.26)	102.27 (12.06)	105.61 (13.28)
FSIQ	103.57 (11.23)	103.62 (11.43)	102.32 (11.40)	108.31 (11.63)

ADHD: Attention Deficit Hyperactivity Disorder, **I:** Inattentive, **C:** Combined, , **VIQ**: Verbal IQ, **PIQ**: Performance IQ, **FSIQ**: Full Scale IQ

2. 2. Measures

2.2.1. Wechsler Intelligence Scale- Revised (WISC-R)

WISC-R is the most widely used intelligence test for assessing children's/adolescents' intelligence level as well as for identifying specific areas of deficit. It was developed (1949) and standardized in 1974 by Wechsler (Savaşır and Şahin, 1995). Age range of the test is between 6 and 16. Verbal IQ, Performance IQ, and Total IQ scores can be gathered. The verbal subtests are consisting of information, arithmetic, similarities, comprehension, vocabulary and digit span (supplemental) categories. The performance subtests are including block design, picture completion, picture arrangement, object assembly, coding, and mazes (supplementary). Subtests of arithmetic**,** picture completion, picture arrangement, block design, object assembly, coding, and mazes have time limitation.

Turkish adaptation of WISC-R has been made by Savaşır and Şahin (1995) with 1639 children age range was 6-16 years. Half reliability of Verbal tests, Performance tests, and Full Scale tests were 0.97, 0.93 and 0.97 respectively. Correlations of subtests were varied between 0.51 and 0.86 (Savaşır and Şahin 1995).

"Information subtests" measures the range of knowledge with composed of questions of general information such as "in which direction does the sun rise?" Presumably, "arithmetic subtest" measures the ability to concentrate through elementary school problems to be solved in subject's head. "Similarities" are measuring abstract thinking with the requirement of pointing out how two things are alike. "Vocabulary subtest" measures vocabulary through with definition of words in increasing difficulty. "Comprehension subtest" items are aiming to measure common sense and practical judgment. "Digit span" is consisting of the repetition of 3 to 9 digits forwards, and 2 to 8 digits backwards in the aim of measuring immediate memory, working memory (digit backwards) and the disruptive effects of anxiety. "Picture completion" is consisting of 26 drawings a missing detail in the aim of measuring alertness to details, visual attention and

visual concentration. “Picture arrangement” subtest is including 12 sets of cartoon like pictures that need to be placed in an appropriate sequence to make a story. It is measuring the ability to plan, judgment and attention. “Block design” is measuring nonverbal reasoning as well as visual analysis and visual synthesis through 9 sets of designs to be reproduced with colored blocks. “Object assembly” measures the ability to perceive part-whole relationships with representation of 5 puzzles representing familiar objects like a girl or a horse to be put together. “Digit symbol” is a code substitution task and is measuring visual-motor functioning with two parts that are alternating in accordance to subject’s age. Part A which is given to age 6 to 8 consists of 5 symbols are paired with 5 geometric shapes. In Part B, 9 symbols are paired with 9 digits. It is given to age 8 from 16. The subject is given a sequence of shapes/ numbers to match hem with the appropriate symbols. “Subtest of mazes” is assessing visuospatial manipulation as well as planning ability, and consisting of 9 mazes with increasing difficulty.

Each subcategory is scored from 1 to 19, with 10 being the average score. The scores of supplemental subtests are not included in the computation of IQ. The classification of Wechsler IQ’s are as follows; 130 & above is very superior, 120— 129 is superior, 110— 119 is high average or bright normal, 90— 109 is average, 80— 89 is low average or dull normal, 70— 79 is borderline, and 69 & below is mentally retarded or mentally defective (Domino, 2002).

2.2.2. Conners’ Parental and Teacher Rating Scale

Conners’ Rating Scales were developed primarily use in drug studies of children with hyperkinesias by Conners in 1969 (Dereboy, Şenol, Şener and Dereboy, 2007). After various revisions “Conners’ Rating Scales” aim to measure attention-deficit/hyperactivity disorder (ADHD) in children and adolescents through parents’ and teachers’ ratings of their behavioral problems as well as oppositional defiant disorder and conduct disorder. The scales correspond with symptoms used in the DSM-IV criteria for ADHD. It also contains an index for assessing children and adolescents at risk for a diagnosis of ADHD. Each item in

the scale is rated on a 4-point scale from 0 = not at all, to 3 = very much by the parents/ teachers

Conners' Parent and Teacher Rating Scales are available in short and long versions and offer alternate measures with varying contents and psychometric properties. In this study, the short version is used. Parent Version - Short Form consists of 48 items, measuring inattentiveness, hyperactivity/impulsivity, oppositional defiant disorder and conduct disorder (Appendix 1). Teacher Version – Short Form consists of 28 items, including similar scales as measured in the Parent Version (Appendix 2).

Turkish adaptation and validity of CPRS-48 and CTRS-28 has been made by Dereboy, Şenol, Şener and Dereboy (2007). Turkish version of the CPRS-48 and CTRS-28 indicated good internal consistency with respectively .95 and .90 of Cronbach's alpha coefficients (Dereboy, Şenol, Şener and Dereboy, 2007). Cronbach's alpha scores of subscales as follows: CPR-I .67, CPR-H .82, CTR-I .83 and CPR-H .72.

Kılıç and Şener (2003) studied the discriminative power of CTR and CPR scales in accordance to subtypes of ADHD with parents and teachers of 105 children, aged 6-11 and diagnosed as ADHD. Results of the study indicated that ADHD subscale of CTRS discriminated between the three subtypes of ADHD (ADHD-I, ADHD-C and ADHD-Hyperactive type). On the other hand, CPRS would also discriminate clinical groups with oppositional defiant disorders and conduct disorders.

2.2.3. Child Behavior Check List (CBCL)

Child Behavior Check List is developed by Achenbach (1991) to be completed by parents or parent surrogates in the aim of obtaining standardized parental report of children's problem behaviors and competencies. Parents provide information on 20 competence items and rate the child on 118 problem items using a 0-1-2 (0 = not true, 1= somewhat or sometimes true, 2=very true or often true) scale on behaviors that is observed in the past 6 months. There are separate

scorings for boys and girls of age 4-11 and 12-18. Concerning the problem behavior scales, raw scores and normalized T scores are available for total problems, internalizing, externalizing, and syndrome scales, which are *withdrawn, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior,* and *aggressive behavior*. Internalizing problem group contains withdrawn, somatic complaints, and anxious/depressed syndrome scales, whereas delinquent behaviors and aggressive behaviors are classified as externalizing problems. Additionally, social problems, thought problems, and attention problems are also separately presented in the scales. Total problem score are to obtain through gathering of all subscale scores (Appendix 3).

In 1981, Akçakın and Savaşır have translated the CBCL in Turkish, and the test reliability was assessed with 80 children who were aged between 6 and 11 years (as cited in, Erol, Kılıç, Ulusoy, Keçeci and Şimşek, 1998). The scale could not be used in the clinical settings due to lack of the norms for different age and sex groups. In 1991, Erol and Kılıç retranslated the scale in Turkish and test-retest reliability was assessed with 50 mothers. Correlation of test-retest reliability was .78 for total accuracy and .84 for total problems. Internal consistency of scale was obtained with 4488 children and adolescents, and internalizing, externalizing, and total problem scores of CBCL indicated good internal consistency respectively .82, .81, and .88 of Cronbach's alpha coefficients (Erol, Kılıç, Ulusoy, Keçeci and Şimşek 1998).

2.2.4. EF Tasks and Dependent Measures

2.2.4.1. Tower of London- Drexel University (ToL^{DX})

The ToL^{DX} was developed by Culbertson and Zilmer (1999) in the aim of measuring higher order problem-solving and "**executive planning"** ability. The information it provides is not only useful when assessing frontal lobe damage, but also when evaluating attention disorders and executive functioning difficulties in children and adults (Culbertson and Zilmer, 1999). Turkish standardization of ToL^{DX} has not been conducted yet for children.

The ToL^{DX} consists of two boards, and each board has three pegs in different heights. The administrator arranges red, green, and blue beads on their pegs. The subject is to move his/her beds from an original starting position to match the position of administrator's beads in as few moves as possible in 10 graded difficulty problems. Therefore, the demand is planning the minimum number of moves required for the solution in each presenting problem. Performance on the task requires the formulation of subgoals and determination of the most advantageous order of simple moves to attain the subgoals and the final goal. There are two rule violations about the movement of pegs. The first rule violation (Type I) occurs when the subject cannot place more beads on a peg than it will hold. The second rule violation (Type II) concerns the rule of moving only one bead at a time. Rule violations are recorded as well as time violations. When the subject fails to solve problem within the first minute of time, time violation is noted on recording form and the subject is allowed to continue problem solving for an additional one minute. If the subject is unable to solve the problem in two minutes, move score is recorded as 20, regardless of the actual move counted at the expiration of time.

Seven scoring variables are recorded. The scores are recorded as follows: Number of moves, number of correct responses, number of total rule violation, total time violation, total initiation time - in other words "planning time" (the latent time between the completing of instructions, and the first move, that is lifting a bead from a peg), total execution time (the amount of time to complete the task), and total problem -solving time (initiation time + execution time).

2.2.4.2. Wisconsin Card Sorting Test (WCST)

WCST was developed by Berg in 1948 and revised by Heaton in 1981 (Karakaş, 2004). WCST provides a measure of ability to identify **abstract reasoning** and **cognitive flexibility in problem solving** as well as **set shifting** (Hodges, 1994; Kaplan and Sadock, 1998; Lezak, 2004). Standardization study for Turkish children age d 6-11 is conducting by Ankara University Medicine Faculty (Bakar and Karakaş, 2007).

The task consists of four stimulus cards, and two sets of 64 response cards of different colors, shapes and numbers. Stimulus cards are put in front of the subject. On the first stimulus card, one red triangle, on the second card two green stars, on the third card three yellow crosses, and on the fourth card four blue circles are printed. The subject receives a set of response cards on which the features of color, form and number vary systematically. They should be sorted into groups by placing the cards one by one under four stimulus cards without any information of the sorting principles. After placing each card, the subject is given the verbal feedback such as "correct" or "incorrect", according to principle so that the subject can find sorting rules from the examiner's responses to each placement of the cards. After ten consecutive correct sorts have been made, the sorting principle is changed (e.g. from color to number) without warning. The test begins with color as the basis of sorting, shifts to form, then to number, returns again to color, and so on. The test ends when each category is being presented twice until 6 categories have been completed, or the two sets of 128 cards have been sorted.

The WCST yields different scores, but the most widely used scores or the main dependent variables of WCST are: Number of categories completed, perseverative responses, perseverative errors, total number of errors and failures to maintain set (Sergeant, Geurts, and Oosterland, 2002),

Concerning perseverative errors as it was measuring set-shifting domains of EFs, patient with the frontal lobe lesions are unable to shift from one sorting criterion to another, and make perseverative errors (Hodges, 1994). Perseverative errors occur either when the subject continues to sort according to previously "correct" principle or, generally, in the first series the subject persists in sorting based on an initial "wrong" guess. Study of developmental norms for the WCST for children indicated that the WCST is able to assess children. Especially, children at the age 10 and over display similar performance with adults (Chelune and Baer, 1986). In addition, Romine et al. (2004) in their sensitivity and specificity study of WCST for children revealed that specific variables of WCST (total number of errors, number of categories completed, perseverative errors) had medium weighed

average effect sizes (d = 0.5) and support the sensitivity of these variables in the presence of ADHD.

2.2.4.3. Verbal Fluency

Verbal fluency measures the ability to generate a novel strategy under a time constraint for guiding an organized search of the internal semantic network (Lezak, 1983). Cognitive processes involved in verbal and category fluency measures consists of processing speed, size of the vocabulary, semantic memory, working memory, inhibition, and set maintenance (Sergeant, Geurts, Oosterlaan, 2002).

Fluency of speech is typically measured by the quantity of words produced within a given time period that either begins with a given letter (letter word fluency) or belongs to a restricted semantic category (semantic word fluency). The generation of words beginning with a specified letter, or form a common semantic category such as animals, fruits, depends on the coordination of two cerebral areas. The first one is the frontal lobes that generate the retrieval strategies and the second one is temporal lobes, where the basic information is stored (Hodges, 1994).

In this research, in the aim of measuring verbal fluency, FAS (for Turkish people KAS) letter fluency task is applied. Subjects are given one minute to name as many words as they can for each letter (K- A- S consequently), excluding proper nouns and plurals. Total words named are being summed to get the total score (Lezak, 1983; Hodges, 1994; Guy and Cummings, 2003). The replication of the same word in each category was recorded as perseverative error.

2.2.4.4. Category Fluency Task

For the category fluency tasks, children are asked to categorize as many as possible, animal and fruit names in order (e.g. Lion - Apple) in one minute of time. Turkish standardization and validity of verbal and category fluency tests have not been conducted yet.

2.2.4.5. Continuous Performance Test (CPT)

This task was designed to assess **sustained attention or vigilance** (persistence of accurate responding) and **impulsiveness** (rapid, inaccurate responding). There is not any standardization study for Turkish children.

In this study, computer-administered CPT in which single letters are shown on a display screen every second. Task of the subject is to push the enter button for appearance of each A letter followed after the Z letter and inhibit his responding when the A letter appears after any letter but Z. The task lasts 4 min. The number of total correct responses, the number of missed targeted stimulus (omission errors), and the number of non-targeted stimulus (commission errors) are derived as the scores of the test. The total number of correct responses and omission errors are seen as measure of sustained attention, while the commission errors score assess both vigilance and impulse control (Barkley, 1997).

2.2.4.6. Go / No-Go Task

"Go / No–Go Task" simply tests the **response inhibition** by the restraining of a strongly established response (Farah, 2003). There are many versions of the tasks. Turkish standardization of Go / No-Go task has not been conducted yet.

In this study, computer based Go/No-Go task is administered. The task of subject was pressing the "enter" button as quickly as he/she can when *one bip* is given (target-go trails) but inhibit the motor response of pressing the button when consequent *two bips* were given (distractor- no go trials). The task lasts 2 minutes with 100 stimuli every second.

Total correct responses, commission and omission errors of Go-No-Go score were used for statistical analysis.

2.2.4.7. Colored Trail Making Task

Colored Trail Making Task aims to measure attention, concentration, resistance to distraction, and cognitive flexibility (set shifting). The test was developed by D'Elia and Satz in 1989. Standardization for Turkish children has not been conducted yet.

The original test was named Trail Making Task (TMT), and was developed by USA army psychologists. TMT consists of two different parts (Part A and Part B). In Part A, subjects are expected to draw lines to connect consecutively numbered circles (1 to 25), and in Part B, they are asked to connect the consequent numbers with consequent letters by alternating between the two sequences (Lezak, Howieson and Loring, 2004). Trail Making Test requires good familiarity with alphabet, and some subjects/children cannot take this test because of unfamiliarity with the alphabet. Therefore, Colored Trail Making Task was developed to assess subjects who are unfamiliar with alphabet.

Colored Trail Making Task (CTT) is administered in two parts: Part A (Color Trails1), and Part B (Color Trails 2). Part A consists of consecutively numbered circles with different colors (pink and yellow) arranged randomly on a sheet of paper. The subject is required to draw a line between the circles in ascending order as quickly as possible. In Part B, two sets of numbers from 1 to 25 are intermixed on the paper and the subject was expected to draw a line connecting numbers sequentially while alternating the colors, such as from pink 1 to yellow 2 and pink 3 so on.

2.2.4.8. Stroop Test

This task is used to assess selective attention and response inhibition. The basic principle of the Stroop Test is to create interference between word reading and color naming. Through interference control, the test is measuring the participant's perceptual set shifting ability to conform to changing demands, e.g. naming ink color without taking account of the printed words or reading the words while ignoring the color of the print (Appendix 4).

Originally, the Stroop Test bases on an experimental study of Stroop in 1935 (Karakaş, 2004). In this study, the Stroop Test TBAG (Turkish Scientific and Technical Research Council of Turkey) was used. Stroop Test TBAG bases on the original Stroop Test and the Victoria version (Kılıç, Şener, Koçkar and Karakaş, 2007). The Stroop TBAG Form was standardized for Turkish children with ages

between 6 and 11 years by Kılıç, Koçkar, Irak, Şener and Karakaş (2002). The reliability measures were conducted by the test–retest method after a 2-months period and reliability coefficients were found to be between 0.63 and 0.81.

Stroop TBAG has five components: In Part 1 (the first card), subjects read aloud color names, which are printed in black ink (STR/1). In part 2 (the second card), subjects read similar color names which are printed in colored ink that doesn't correspond with the color of name and must be ignored (STR/2). In Part 3 (the third card), subjects have to name the color of colored dots (STR/3). In Part 4, the subject has to name color of colored neutral words (STR/4), and in Part 5 (fifth card), the subjects name color of colored words where color and meaning are incongruent for the words (STR/5). Therefore color-word interference effect is measured in Part 5 (STR/5), referring the finding that normal individuals take longer to name the color of the ink rather than reading the words. The completion time / duration (D), number of errors (E), and number of corrected responses (C) for each five part of the test are recorded (Kılıç, Koçkar, Irak, Şener and Karakaş, 2002).

2.2.4.9. California Verbal Learning Test – Children's Version (CVLT-C)

The CVLT–C was developed by Delis, Kramer, Kaplan and Ober in 1994, and designed to assess and quantify verbal learning, recalling and recognition as well as the strategies and processes involved in both learning outcome (e.g., delayed recall) and learning process (e.g. semantic clustering) through the context of an everyday shopping task in which the child is asked to recall a list. The CVLT-C is administered to children aged 5 to 16, and the test manual states that several learning process indices relate to metacognitive organizational skills, suggesting a link to executive functioning such as attention, working memory, and strategy formulation (Delis, Kramer, Kaplan, and Ober, 1994). Turkish adaptation of CVLT-C has been made by Gürvit (1997), but any reliability of validity study has not been done yet.

The CVLT-C consists of two different shopping lists that are List A (Monday shopping list) and List B (Tuesday shopping list). Each list includes fifteen words (items) with five words from each of the three semantic categories (e.g. clothing, toys and fruits). The words are mixed up so that no two words from the same category are presented consecutively. List A is read to the subject for the first five trials and he/she is asked to recall as many words as possible from the list after each presentation. Then, List B is presented as an interference list and the subject is asked to recall as many words from this list as he/she can. After completing List B, the subject is again asked to recall words from List A without an additional presentation of List A in the aim of assessing "Short Delay Recall" as well as interference of List B. As it was mentioned above, the 15 words on List A are categorized as clothing, toys, and fruits (Appendix 5). These categories are used as cues to elicit words from the original list, for assessing Cued Delay Recall. The CVLT-C is then set aside for 20 minutes, during which time the subject completes nonverbal tasks. At the end of 20 minutes, "Long Delay" interval: Firstly, subject is asked to recall as many words as from List A as he/she can (Long delay recall). Secondly, after free recalling words from List A, category cues were provided and the subject asked to recall as many word as possible for each category (Long delay cued recall). Thirdly, subjects were asked to recognize the 15 words whether or not each was on List A from a list of 45 words read aloud in the aim of assessing Long-Delay Recognition. In this way, CVLT-C assessing measures of short- and long-term memory performance, including 8 recall and 4 recognition measures. It also provides data on encoding strategies and errors, such as intrusions and perseveration (Delis, Kramer, Kaplan and Ober,1994).

Ten sub-scores were selected to be included in the analysis of trails. Total recall of List A was used to measure cumulative immediate recall across five presentations of the word list. Short delay free recall was used to provide an estimate of immediate auditory recall. Long delay free recall was used to measure auditory recall after a 20-minutes interval. Short delay cued recall and long delay cued recall were used to distinguish encoding from retrieval problems. Correct

recognition hits, and false positives were used to measure response discrimination. The semantic cluster ratio score was used as an indicator of the extent to which the child used an active learning strategy, perseveration rate was used as an indicator of attention, and the intrusion rate was used as a measure of interference rate.

2.2.4.10. Bender-Gestalt Test (The Bender Visual Motor Gestalt Test)

Bender-Gestalt Test is an efficient measure of psychological assessment to evaluate visual-motor functioning, visual-perceptual skills, cognitive development, neurological impairment, and emotional disturbances in children and adults. It is used to evaluate visual-motor maturity and to screen children for developmental delays and designed to use in educational, research, and clinical settings.

The original Bender Visual Motor Gestalt Test was developed in 1938 by psychiatrist Lauretta Bender (Lezak, Howieson, and Loring, 2004). Turkish standardization of the Bender-Gestalt Test was made by Somer in 1988 with 701 primary school students. Test-retest reliability was found .80 for students in primary school first grade, .73 for second grade, and .81 for the third grade (in Bakar and Karakaş, 2007).

There are several different versions, and all use the same basic test materials, but vary in their scoring and interpretation methods. The standard Bender Visual Motor Gestalt Test consists of nine geometric designed cards (numbered A, and 1-8) to demonstrate the perceptual tendencies to organize visual stimuli into configural wholes. Each design was presented sequentially to the subject and asked to copy the best reproduction of the figure possible onto a blank sheet of paper. The test is not time limited. The scoring considers accuracy and organization. Common features considered in evaluating the drawings are rotation, distortion, symmetry, and perseveration. As an example, a patient with frontal lobe injury may reproduce the same pattern over and over (perseveration). Every mistake is given 1 point, regardless of the geometric design, and highest score of test is 30 (Bakar and Karakaş, 2007).

2.2.4.11. Cancellation Test

Cancellation Test (CT) was originally developed by Weintraub and Mesulam in 1985 (Bakar and Karakaş, 2007). CT requires visual selectivity at fast speed on a repetitive motor response. The test assesses many functions; it measures not only the capacity of sustained attention, but at the same time the also the sensory component related with perceptual representations, motor component

related with visual search and scan, and motivational component related with affect. Therefore, for a successful performance, visual scanning, activation and inhibition of rapid responses are necessary (Lezak, 1983).

Turkish version of CT was standardized for Turkish children between the ages 6 and 11 years. Turkish norm study was carried out with 291 primary school children. Test-retest reliability varies between 0.45 and 0.83, assessed in 101 children (Kılıç, Irak, Koçkar, Şener and Karakaş, 2002).

Cancellation Test consists of four separate sheets that consist of letters and figures either organized or randomly interspersed with a designated target letter or figure. The test has four subtests: organized letters, organized figures, random letter, and random figures (Appendix 6). Subtests are applied in a sequential order such as organized letter, random letter, organized figure, and random figure. Each subtest contains 60 target items. Subjects are required to circle the target stimuli. After every 10 correct responses, the colored pencil is changed with the information of subject, in the aim of assessing cancellation strategy, e.g. planned or mixed. Six different scores are recorded for each subtest as follows: scores of correct responses, omission errors, commission errors, total number of incorrect responses, time to completion/duration, and cancellation strategy

2.3. Procedure

In the ADHD group, each child should be given the diagnosis of ADHD-I, ADHD-C or ADHD-Comorbide type according to DSM-IV criteria by a specialized child psychiatrist. These children were directed to further

neuropsychological assessment. In the first meeting, informed consent was given to parents. Each child's parent was interviewed in the aim of assessing the child's psychomotor activity to screen the DSM-IV criteria set for ADHD, Conduct Disorder (CD) and Oppositional Defiant Disorder (ODD). Parents (and teachers) of each subject completed the Conner's Rating Scale and Child Behavior Checklist. If the clinical interview and Conner's Rating Scale confirmed the ADHD diagnosis made by the child psychiatrist, the children were given the WISC-R; and only 90 and over FSIQ scored subjects were given the EF tasks.

Children in the ADHD groups were referred from Bakırköy Sadi Konuk Teaching and Research Hospital in Istanbul, by a specialized child psychiatrist. The control group was recruited from the local schools with permission of parents and teachers. At the end of neuropsychological assessment, a comprehensive report was send to the referring child psychiatrist. In addition, the parent of each child was informed about the outcome of assessment.

Assessment sessions were completed in three settings. In the first one, parents of children were interviewed via DSM-IV TR assessment scales for ADHD, ODD and CD; and the demographic assessment sheet prepared by the researcher was filled. At the end of the first session, a further appointment was given for IQ testing. In the second session, WISC-R was applied to the child in approximately two hours time. If FSIQ was equal or above 90, the parent was given Conner's Parental Rating Scale, Child Behavior Check List to be filled, and Conner's Teacher Rating Scale was given to be filled by the teacher. One week after the second session, the Executive Function Tests / Tasks are applied in the third session and the filled Conner's Teacher Rating Scale sheets are recollected. In this two-hours-session, EF measures were applied to the child in a mixed order. After completing the first part of the California Verbal List Test for Children (CVLT-C), either Tower of London or Cancellation Task was applied in about 20 minutes and thereafter the second part of the CVLT-C.

Exclusionary factors were including low intelligence (FSIQ score below 90), history of seizure disorders, history of traumatic brain injury warranting

medical attention or a previous diagnosis of any psychiatric disorder including behavioral disorder, learning disability and autism. The age ranges of subjects were between 7 and 12. Fifteen subjects were excluded due to low full intelligence score (FSIQ < 90). In addition, 15 subjects of the normal control group, who have FSIQ 120 and above were excluded, in the aim to match the FSIQ scores with the study groups. Three subjects from ADHD-Comorbide group and one subject from ADHD-C group couldn't complete the assessment, due to excessive hyperactivity, inattention and distractibility.

CHAPTER 3

RESULTS

As stated earlier, this study investigated behavioral problems and executive function deficits in children with ADHD-I type, ADHD-C type, ADHD-Comorbid and normal controls. In this section, the results of this study are presented. Following the presentation of results, implications and conclusions as well as limitations of study presented under the discussion section.

3.1. Preliminary Analyses

Before assessing the differences and relationships between the groups, in the aim of assessing normality outliers was analyzed. Skewness and Kurtosis statistics were run to overview the distribution of continuous variables. Variables that were indicating outliers were assessed whisker plots to see if there any outliers that deserve investigation. After detecting outliers, Z value was computed. Generally, Zvalue = 3.26 and above was used for deleting subjects who are deviated from the normal disturbances unexpectedly. In some cases, outliers were remained as they were expectedly deviated e.g. a subject in the control group would finish the task earlier than study groups. Because of the excessive amount of variables, information that is more detailed was given before the analysis of the test results that have outliers.

There were not many missing values in EF variables only one child couldn't finish the assessment due to health problems, one child couldn't complete verbal fluency tests, and two children couldn't take WISC-R mazes subtest. Therefore missing values remained out of the statistical analysis.

3.2. Comparison of Demographic Characteristics of Children

Children in the four different groups were compared according to their history of pregnancy, birth and sleeping pattern records using Chi-square analysis, and the outcome is presented in Table 6: 78% of control group children's mothers had planned pregnancy, while 46% of ADHD- Comorbid group children's mothers did not planned to have the index child, but the difference wasn't significant. Concerning the psychological and medical history of pregnancy, there were significant differences between the groups [Chi-square (6, N=147) = 19.89, $p<.01$]: 83% of control group children's mothers had normal pregnancy, while 49% of mothers in the ADHD-Combined type group suffered of stressful conditions (usually family and marital problems) and 16% of ADHD-I and ADHD-Combined group mothers had some medical problems. Significant Chi-Square outcome was assessed through using post-hoc Chi-square test, and outcome indicated that significantly less mothers in Control group had stress during their pregnancy than mothers in ADHD-Comorbid group [Chi-square (1, N=23) = 7.35, $p<.01$], mothers in ADHD-C group [Chi-square (1, N=19) = 4.26, $p<.05$], and mothers in ADHD-I group [Chi-square (1, N= 20) = 5.00, $p<.05$].

There was not any significant difference concerning birth difficulties between the groups [Chi-square (6, 147) = 2.0, $p>.05$]. Present sleeping pattern of children did not differ between the groups [Chi-square (3,147) = 3.3, $p>.05$]. On the other hand, there was a significant difference in sleeping pattern as a baby [Chi-square (3, N=147) = 12.29, $p<.01$], and 70% of children had normal sleeping pattern as a baby in the control group, while 68% ADHD-Combine and 62% of ADHD-C Group children were sleeping less than normal. Chi-square post-hoc comparison revealed that; subjects in ADHD- Comorbid group were significantly less sleeping as a baby than subjects in Control group [Chi-square (1, N=37) = 4.57, $p<.05$]. Other groups didn't significantly differ between them in terms of the sleeping pattern.

Table 6. Pregnancy, Birth and Sleeping Pattern of the Children in the Groups

	ADHD-I		ADHD-C		ADHD-Comorb.		Control		Chi Square
	(n)	%	(n)	%	(n)	%	(n)	%	
Planned Pregnancy									5.74
Yes	(27)	73.0	(27)	73.0	(20)	54.1	(28)	77.8	
No	(10)	27.0	(10)	27.0	(17)	45.9	(8)	22.2	
Pregnancy									**19.89****
Normal	(16)	43.2	**(18)**	**48.6**	(13)	35.1	**(30)**	**83.3**	
Under Stress	(15)	40.5	(14)	37.8	**(18)**	**48.6**	(5)	13.9	
Medical Problems			(5)	13.5	(6)	16.2	(1)	2.8	
Birth									2.03
Normal	(24)	64.9	(21)	56.8	(19)	51.4	(22)	61.1	
Caesarian	(9)	24.3	(12)	32.4	(12)	32.4	(9)	25.0	
Complication	(4)	10.8	(4)	10.8	(6)	16.2	(5)	13.9	
Sleeping as Baby									**12.29****
Normal	(20)	54.1	(14)	37.8	(12)	32.4	**(25)**	**69.4**	
Less than Normal	(17)	45.9	(23)	62.2	**(25)**	**67.6**	(11)	30.6	
Present Sleeping									3.29
Normal	(28)	75.7	(28)	75.7	(27)	73.0	(32)	88.9	
Less than Normal	(9)	24.3	(9)	24.3	(10)	27.0	(4)	11.1	

**p<.01.

Information about school achievement, reading and writing ability, and peer relations were obtained from parents, and were presented in Table 7: According to Chi-square analysis, there is a significant difference between groups concerning the school achievement. Seventy five percent of control group children had high, 54% of ADHD-I group had medium, and 35% of ADHD-Comorbid had low school achievement [Chi Square (6, N=147) = 36.6, p<.01]. Post-hoc Chi-square analysis results indicated that subject in control group had significantly higher school achievement than subject in ADHD-I group [Chi-square (1, N= 33) = 13.36, p<.000], and subjects in ADHD-Comorbid group [Chi-square (1, N=38) = 6.74, p>.01]. In addition, school achievement of subjects in ADHD-C was significantly higher than subjects in ADHD-I group [Chi-square (1, N=23) = 5.26, p>.05].

There were significant differences between the groups according to their reading [Chi-square (3, N=147) = 8.88, p<.05]. Forty one percent of ADHD-Comorbid group children began to read in the second term of the first primary school year, while 89% of control children began to read during the first year / first term. Group differences were assessed and subjects of beginning to read first year second term was significantly more in ADHD-C group than Control group [Chi-square (1, N=19) = 6.37, p<.01]. There were not any significant differences between comparisons of groups in the terms of beginning to read.

Concerning the parental reported writing ability; there was a significant difference between the groups in terms of their writing ability [Chi-square (6, N=146) = 15.29, p<.05]. Comparisons of group differences indicated that subjects in ADHD-Comorbid group and Control group significantly differed in two categories of writing ability: normal writing and missing letters. In accordance, significantly less subjects in ADHD-Comorbid group had normal writing ability than subjects in Control group [Chi-square (1, N= 42) = 4.67, p<.05], while subjects in ADHD-Comorbid group had significantly higher problems of missing letters in writing than subjects in Control group [Chi-square (1, N=18) = 8.00, p<.01].

Outcome of peer relations significantly differed between the groups [Chi-square (6, N=147) = 40.62, p<.000]. Group comparisons of Chi-square tests yielded that subjects in Control group had significantly more normal peer relations than subjects in ADHD-C group [Chi-square (1, N=49) = 5.90, p<.05] and subjects in ADHD-Comorbid group [Chi-square (1, N=43) = 12.30, p<.000]. In addition, subjects in ADHD-I group had significantly normal peer relations than subjects in ADHD-Comorbid group [Chi-square (1, N=32) = 4.50, p<.05]. Fighting with peers was significantly differed between ADHD-C and ADHD-I groups, so subjects in ADHD-C groups had significantly more fighting with peers than subjects in ADHD-I group [Chi-square (1, N=21) = 3.86, p<.05]. On the other hand, subjects in ADHD-Comorbid group and ADHD-I group were significantly more rejected by their peers than subjects in ADHD-I group [Chi-square (1, N=18) = 10.89, p<.001, Chi-square (1, N=11) = 4.45, p<.05 respectively].

Table 7. School Achievement, Reading and Writing Ability, Peer Relations of the Children as reported by the parents

	ADHD-I		ADHD-C		ADHD-Comorb.		Control		Chi Square
	(n)	%	(n)	%	(n)	%	(n)	%	
School Achievement									**36.62****
High	(6)	16.2	(17)	45.9	(11)	29.7	**(27)**	**75.0**	
Medium	**(20)**	**54.1**	(9)	24.3	(13)	35.1	(9)	25.0	
Low	(11)	29.7	(11)	29.7	(13)	35.1			
Beginning to Read									**8.88***
First Year-First Term	**(26)**	**70.3**	**(29)**	**78.4**	(22)	59.5	**(32)**	**88.9**	
First Year-Second Term	(11)	29.7	(8)	21.6	(15)	40.5	(4)	11.1	
Writing Ability									**15.29****
Normal	**(22)**	**61.1**	(17)	45.9	(14)	37.8	**(28)**	**77.8**	
Dysgraphia	(6)	16.7	(9)	24.3	(8)	21.6	(5)	13.9	
Missing Letters	(8)	22.2	(11)	29.7	(15)	40.5	(3)	8.3	
Peer Relations									**40.62*****
Normal	**(22)**	**59.5**	(16)	43.2	(10)	27.0	**(33)**	**91.7**	
Fighting with Peers	(6)	16.2	(15)	40.5	(11)	29.7	(1)	2.8	
Rejected by Peers	(9)	24.3	(6)	16.2	(16)	43.2	(2)	5.6	

***p<.001, **p<.01, *p<.05.

3.3. Relationship among, Conner's Parental-Teacher Rating Forms, Wechsler Intelligence Scale for Children, Child Behavior Check List and Executive Functions

The relationship between grouping and dependent variables was reported under two headings. Under the first heading, relationship of grouping variables in between was reported. Under the second heading, relationship between grouping variables and executive function test scores was evaluated.

3.3.1. Relationship between Conner's Rating scales, WISC-R and Child Behavior Check List

In the aim of assessing relationship between Conner's parent and teacher ratings, WISC-R Intelligence Quotient, Child Behavior Check List and Executive

Function measures, Pearson Product Moment Correlation were used. Table 8-11 are presenting outcome of correlation results between CPRS, CTRS Inattentive, Hyperactivity, WISC-R VIQ, PIQ, FSIQ and CBCL Internalizing, Externalizing, Total Problem scores for each study group separately.

There was a significant negative relationship between Conner's Teacher Rating Scale Inattentive score and WISC-R Verbal ($r = -.53$, $p<.001$), Performance ($r = -.63$, $p<.000$) and Total Intelligence ($r = -.64$, $p<.000$) scores for ADHD-I group (Table 8). It means, CTR-I scores indicate lower WISC-R VIQ, PIQ and FSIQ for ADHD-I type children. On the other hand there was a significant positive relationship between CPR-I score and CBCL Internalizing ($r = .43$, $p<.01$), Externalizing ($r = .34$, $p<.01$), Total Problem ($r = .42$, $p<.01$) scores. CPR-H score had a significant positive relationship with CBCL Externalizing score ($r = .47$, $p<.01$). In addition, there were significant negative relationships between CTR-H score and CBCL Externalizing ($r = -.43$, $p<.01$) and CBCL Total problem ($r = -.49$, $p<.01$) scores. Overall, the parental rating of inattentiveness was focused on social life, while teacher rating of inattentiveness was related with academic life.

Table 8. Correlation results of ADHD-I Group

	CPR-I	**CTR-I**	**CPR-H**	**CTR-H**	**VIQ**	**PIQ**	**FSIQ**	**CBCL Inter.**	**CBCL Exter.**	**CBCL Total**
CPR-I	1									
CTR-I	.22	1								
CPR-H	.12	-.14	1							
CTR-H	-.07	-.10	-.11	1						
Verbal IQ	-.19	**-.53****	.16	.10	1					
PerformanceIQ	-.18	**-.63****	.07	-.14	**.46****	1				
Full Scale IQ	-.21	**-.64****	.14	-.03	**.86****	**.83****	1			
CBCL Internalizing	**.43***	.04	.09	-.26	-.15	-.03	-.11	1		
CBCL Externalizing	**.34***	.08	**.47****	**-.43***	-.08	.00	-.04	.56**	1	
CBCL Total	**.42***	.11	.31	**-.49****	-.15	-.02	-.09	**.82****	**.88****	1

CPR-I: Conner's Parental Rating Scale- Inattentiveness, **CTR-I**: - Inattentiveness**, CPR-H**: Conner's Parental Rating Scale- Hyperactivity, **CTR-H**: Conner's Teacher Rating Scale – Hyperactivity, **VIQ**: WISC-R Verbal IQ, **PIQ**: WISC-R Performance IQ, **FSIQ**: WISC-R Full Scale IQ, **CBCL**: Child Behavior Check List.
*p<.01, **p<.001

In ADHD-C Group (Table 9), CPT-I and CTR-I weren't significantly correlated with WISC-R and CBCL scores. There was a significant correlation between CPR-H score and CBCL Externalizing ($r = .47$, $p<.01$) and Total Problem ($r = .47$, $p<.01$) scores. WISC-R VIQ score was significantly positively correlated with CTR-H score ($r = .36$, $p<.01$), while a significant negative correlation was observed between VIQ score and CBCL Externalizing score ($r = -.37$, $p<.01$). CPR-I, and CTR-I were not significantly correlated, indicating that parents and teachers were reporting different aspects of inattentive behavior. Parents were focusing on social life, whereas teachers were focusing mostly on academic life.

Table 9. Correlation results of ADHD-C Group

	CPR-I	**CTR-I**	**CPR-H**	**CTR-H**	**VIQ**	**PIQ**	**FSIQ**	**CBCL Inter.**	**CBCL Exter.**	**CBCL Total**
CPR-I	1									
CTR-I	.06	1								
CPR-H	.34	-.22	1							
CTR-H	-.30	-.23	-.08	1						
Verbal IQ	-.24	-.16	-.10	**.36***	1					
Performance IQ	-.06	-.30	-.02	-.06	**.50****	1				
Full Scale IQ	-.09	**-.25***	-.07	.18	**.84****	**.89*****	1			
CBCL Internalizing	.02	-.07	.14	-.06	-.10	-.20	.18	1		
CBCL Externalizing	.14	-.22	**.47***	-.13	-.37*	-.11	-.26	**.39***	1	
CBCL Total	.20	-.20	**.47***	-.11	-.17	.09	-.02	**.76*****	**.85*****	1

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: - Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale – Hyperactivity, CBCL: Child Behavior Check List.
*p<.01, **p<.001, ***p<.000

In ADHD-Comorbid Group (Table 10), CTR-I was significantly related with CPR-I ($r = .41$, $p<.01$) and CTR-H ($r = .39$, $p<.01$) scores. There were significant relationship between CBCL Internalizing score and PIQ ($r = .51$, $p<.01$), FSIQ ($r = .44$, $p<.01$) scores

Table 10. Correlation results of ADHD-Comorbid Group

	CPR-I	**CTR-I**	**CPR-H**	**CTR-H**	**VIQ**	**PIQ**	**FSIQ**	**CBCL Inter.**	**CBCL Exter.**	**CBCL Total**
CPR-I	1									
CTR-I	**.41***	1								
CPR-H	-.19	-.09	1							
CTR-H	-.25	.35	.37	1						
Verbal IQ	-.16	.04	.21	.33	1					
Performance IQ	-.27	-.22	-.05	-.04	**.45****	1				
Full Scale IQ	-.25	-.11	.09	.18	**.86****	**.84****	1			
CBCL Internalizing	.21	-.02	-.15	-.29	.23	**.51****	**.43****	1		
CBCL Externalizing	.10	.07	-.06	-.12	-.09	.16	.04	**.45****	1	
CBCL Total	.28	.09	-.15	-.27	-.07	.22	.09	**.75****	**.89****	1

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: - Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale – Hyperactivity, CBCL: Child Behavior Check List
*p<.01, **p<.001

In control group (Table 11), CPR-I score was significantly correlated with CTR-I ($r = .46$, $p<.01$), CPR-H ($r = .49$, $p<.01$), CBCL Internalizing ($r = .42$, $p<.01$), Externalizing ($r = .40$, $p<.01$) and Total Problem ($r = .52$, $p<.001$) scores. There were a significant relationship between CTR-I score and VIQ ($r = .58$, $p<.001$), FSIQ ($r = .53$, $p<.001$), CBCL Externalizing ($r = .43$, $p<.01$) and Externalizing ($r = .39$, $p<.01$) scores. In addition, CPR-H score was significantly positively related with CBCL Externalizing ($r = .44$, $p<.01$) and Total problem ($r = .41$, $p<.01$) scores. Overall, parental and teacher rating of inattentiveness scores indicated that parents and teachers focused both on academic and social life.

Table 11. Correlation results of Normal Control Group

	CPR-I	CTR-I	CPR-H	CTR-H	VIQ	PIQ	FSIQ	CBCL Inter.	CBCL Exter.	CBCL Total
CPR-I	1									
CTR-I	**.46****	1								
CPR-H	**.49****	.12	1							
CTR-H	.03	.25	.27	1						
Verbal IQ	-.13	**.58****	.15	-.01	1					
Performance IQ	-.27	**-.34***	.03	.12	**.52****	1				
Full Scale IQ	-.24	**.53****	.09	.06	**.85****	**.89****	1			
CBCL Internalizing	**.42***	.32	.28	.13	.02	.17	.01	1		
CBCL Externalizing	**.40***	**.43***	**.44****	.14	-.11	.10	-.01	**.71****	1	
CBCL Total	**.52****	**.39***	**.41***	.17	-.02	.06	.02	**.92****	**.88****	1

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: - Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale- Hyperactivity, CBCL: Child Behavior Check List.

*p<.01, **p<.001

3.3.2. Relationship between Conner's Rating scales, WISC-R, Child Behavior Check List and Executive Functions Tests / Tasks

The relationship between each EF tests and Inattentive, Hyperactive scores of CPRS and CTRS, Verbal IQ, Performance IQ, Full Scale IQ of WISC-R, Internalizing, Externalizing and Total scores of CBCL were examined, and separate correlation analysis were carried out for four study groups. Only significant outcomes were reported for each group and p<.01 was taken as significance level.

Table 12 is presenting significant correlation outcome for ADHD-I group. Neither CPR-I, nor CPR-H was significantly related to an EF test. On the other hand, CTR-I score was significantly related with Go-No-Go Commission error (r = .45, p<.01), WCST Total Number of Errors (r = .59, p<.01), and WCST Perseverative Errors (r = .48, p>.00). In addition, WCST Number of Categories Completed (r = -.52, p<.000) and Percent of Conceptual Level Responses (r = -.43, p<.01) had a negative significant correlation with the CTR-I score. CTR-H score

had a significant negative relationship with K-A-S ($r = -.41$, $p < .05$), ToL Number of Correct responses ($r = -.44$, $p < .01$) and ToL Total Initiation Time ($r = -.44$, $p < .01$).

There was not any significant relationship between VIQ scores and EF tests at $p < .01$ significance level. PIQ score had a negative significant relationships with WCST Total Number of Errors ($r = -.46$, $p < .001$), WCST Perseverative Responses ($r = -.42$, $p < .01$) and WCST Perseverative Errors ($r = -.46$, $p < .01$). Significant negative correlation was obtained between FSIQ score and WCST Total Number of Errors ($r = -.39$, $p < .01$).

Concerning CBCL Internalizing, Externalizing and Total Problem scores; CT Organized Letters Correct Responses were significantly related with CBCL Internalizing score ($r = .44$, $p < .01$), and CBCL Total Problem score ($r = .44$, $p < .01$), while CBCL Externalizing score had significant positive correlation with ToL Number of Correct Responses.

Table 12. ADHD- I Group Correlation results of Conner's, Intelligence, Behavior Problems and Executive Function.

	CPR-I	CTR-I	CPR-H	CTR-H	VIQ	PIQ	FSIQ	CBCL Inter.	CBCL Exter.	CBCL Total
K-A-S	.02	-.11	.05	**-.41***	.11	.12	.15	-.12	.15	-.00
Go-no-go Commission Error	-.00	**.45***	-.11	.21	-.25	-.16	-.26	-.17	.02	-.06
WCST Total Number of Errors	.17	**.59*****	-.05	.26	-.22	**-.46****	**-.39***	.01	.09	.06
WCST Number of Categories Completed	-.15	**-.52****	.24	-.31	.18	.30	.28	.13	.05	.06
WCST Perseverative Responses	-.01	**.43***	-.10	.31	-.10	**-.42***	-.30	-.01	-.04	-.02
WCST Perseverative Errors	.03	**.48****	-.11	.31	-.14	**-.46***	-.35	-.02	-.05	-.03
WCST Percent of Conceptual Level Responses	-.07	**-.43***	.11	-.26	.17	.30	.26	.07	-.04	-.03
ToL Number of Correct Responses	.36	.09	.27	**-.44***	-.09	-.16	-.14	.21	**.44***	.35
ToL Total Initiation Time	-.03	.06	-.21	**-.44***	-.24	-.07	-.18	.01	.02	.03
CT Organized Letters Correct Responses	-.04	-.23	.13	-.24	-.01	.12	.04	**.44***	.31	**.44***

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: - Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale – Hyperactivity, VIQ: Verbal IQ, PIQ: Performance IQ, FSIQ: Full Scale IQ, CBCL-inter.: Child Behavior Check List Internalizing, CBCL-Exter: Child Behavior Check List Externalizing, CBCL Total: Child Behavior Check List Total Problem, K-A-S: Verbal Fluency Test, WCST: Wisconsin Card Sorting Test. ToL: Tower of London, CT: Cancellation Task.

*p<.01, **p<.001, ***p<.000

According to Table 13, CPR-I and CPR-H scores did not have any significant relationship with any EF tests score in the ADHD-C Group. There was a significant positive relationship between CTR-I score and CPT Omission Errors(r = .40, p<.01).WCST Perseverative Responses (r = -.44, p<.01) and WCST Perseverative Responses (r = -.44, p<.01) were negatively related with CTR-H

score. FSIQ score was significantly related with Go-No-Go Commission Errors (r = .44, p<.01). Significant correlation was obtained between CBCL Externalizing score and Animal-Fruit Category perseverative responses (r = .54, p<.001).

Table 13. ADHD-C Group Correlation results of Conner's, Intelligence, Behavior Problems and Executive Functions

	CPR-I	CTR-I	CPR-H	CTR-H	VIQ	PIQ	FSIQ	CBCL Inter.	CBCL Exter.	CBCL Total
Category Perseverative	.19	-.00	.21	.05	-.10	-.19	-.17	.01	**.54****	.38
CPT Omission Errors	.16	**.40***	.10	.23	.12	.02	.09	.14	.15	.22
Go-no-go Commission errors	.01	.07	-.12	.13	.37	.38	**.44***	.13	-.13	-.04
WCST Perseverative Responses	-.19	-.02	-.06	**-.44***	-.02	.10	.03	.05	-.03	-.05
WCST Perseverative Errors	-.21	-.00	-.07	**-.44***	-.05	.06	-.01	.02	-.04	-.08

CPR-I: Conner's Parental Rating Scale- Inattentiveness, **CTR-I**: - Inattentiveness, **CPR-H**: Conner's Parental Rating Scale- Hyperactivity, **CTR-H**: Conner's Teacher Rating Scale – Hyperactivity, **VIQ**: Verbal IQ, **PIQ**: Performance IQ, **FSIQ**: Full Scale IQ, **CBCL :** Child Behavior Check List, **CBCL-inter**: CBCL Internalizing, **CBCL-Exter**: CBCL Externalizing, **CBCL Total**: CBCL Total Problem, **WCST**: Wisconsin Card Sorting Test.

*p<.01, **p<.001

In ADHD- Comorbid Group (Table 14), CPR-I score had significant negative correlations with CVLT-C Total Semantic Cluster (r =-.45, p<.01), CVLT-C Correct Recognition Hits (r = -.48, p<.01), CVLT-C Discriminability (r = -.41, p>.01), and had positive correlation with CPT Omission Error (r = .47, p<.01). There was a significant positive correlation between CT Random Shapes Errors and CTR-I score (r =.46, p<.01). CPR-H score had significant positive correlation with CVL-T Total recall (r =.42, p<. 01) and CVLT-C Correct Recognition Hits (r = .48, p<. 01), while revealing negative correlation with CVLT-T Total Intrusion (r = -.40, p<.01) and CT Duration of Random Shapes (r = -.42, p<.01). CTR-H score didn't have any relationship with EF Tests scores. There was a negative correlation between WISC-R Verbal IQ score and Stroop

Interference score ($r = -.45$, $p<.01$). CT Organized Letters Correct Responses were significantly related with WISC-R Performance IQ score ($r = .44$, $p<.01$) and Full Scale IQ score ($r = .43$, $p<.01$). In addition, Go-No-Go Omission Error score had a negative correlation with PIQ score ($r = -.42$, $p<.01$) and FSIQ score ($r = -.44$, $p<.01$).

CBCL Internalizing score of ADHD- Comorbid Group did not relate to any EF tests score at .01 significance level. On the other hand, CBCL Externalizing and Total Problem scores had negative correlation with WCST Failure to Maintain Set score ($r = -.55$, $p<.001$, $r = -.48$, $p<.01$ respectively). CT Random Letters Error score significantly related with CBCL Internalizing ($r = .44$, $p<.01$) and CBCL Total Problem score ($r = .44$, $p<.01$).

Table 14. ADHD-Comorbid Group's Correlation results of Conner's, Intelligence, Behavior Problems and Executive Functions

	CPR-I	CTR-I	CPR-H	CTR-H	VIQ	PIQ	FSIQ	CBCL Inter.	CBCL Exter.	CBCL Total
CVLT-C Total Recall	-.30	-.04	**.42***	.25	.13	.05	.11	.07	-.13	-.03
CVLT-C Total Intrusion	.07	.00	**-.40***	-.24	-.21	-.10	-.18	-.03	.03	.04
CVLT-C Total Semantic Cluster	**-.45***	-.25	.28	.09	.08	.05	.08	.09	-.22	-.10
CVLT-C Correct Recognition Hits	**-.48***	-.33	**.48***	.03	-.03	-.05	-.05	-.22	-.39	-.35
CVLT-C Discriminability	**-.41***	-.29	.30	-.02	.11	.11	.14	-.12	-.19	-.18
CPT Omission	**.47****	.19	-.15	-.03	-.08	-.18	-.16	-.06	.07	.08
Go-no-go Omission	.09	.01	-.06	.10	-.33	**-.42***	**-.44***	-.37	.05	-.09
Stroop Interference	-.05	-.16	-.04	-.30	**-.45***	-.15	-.36	-.35	-.31	-.31
WCST Failure to Maintain Set	-.33	-.22	.03	.04	.16	.28	.24	-.05	**-.55****	**-.48****
CT Organized Letters Correct Responses	-.25	-.07	.06	.05	.31	**.44***	**.43***	.04	-.09	-.08
CT Random Letters Errors	.12	.13	-.38	-.05	-.19	.08	-.06	.22	**.44***	**.44***
CT Duration of Random Figures	-.16	-.12	**-.42***	-.11	-.16	.12	-.03	-.25	-.16	-.26
CT Random Figures Errors	.23	**.46***	-.03	.17	.12	-.21	-.05	.19	.05	.11

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: Conner's Teacher Rating Scale: -Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale – Hyperactivity, VIQ: Verbal IQ, PIQ: Performance IQ, FSIQ: Full Scale IQ, CBCL-inter. Child Behavior Check List Internalizing, CBCL-Exter: Child Behavior Check List Externalizing, CBCL Total: Child Behavior Check List Total Problem, CVLT-C: California Verbal Learning Test for Children, CPT: Continuous Performance Test, WCST: Wisconsin Card Sorting Test, CT: Cancellation Task.

*p<.01, **p<.001

Table 15 is presenting correlation results of normal Control group. CPR-I score had a significant negative correlation with CVLT-C Total Recall (r = -.63, p<.000), CVLT-C Short Free Recall (r = -.57, p<000), CVLT-C Long Free Recall (r = -.61, p<.001), CVLT-C Total Perseveration (r = -.43, p<.01), CVLT-C Total

Semantic Cluster (r = -.46, p<.01), and CVLT-C Discriminability (r = -.53, p<.001). There was a significant positive correlation between CVLT-C False Positive and CPR-I scores (r = .53, p<.001). CTR-I was significantly positively related with CVLT-C Total recall (r = -.41, p<.01), CVLT-C Short Free Recall (r = -.47, p<.01) and Bender-Gestalt Test (r = -.42, p<.01). There was significant positive correlation between STR/5 Time (r =.40, p<.01), ToL Total time Violation (r = .41, p<.01) and CPR-H, while negative correlation was existing between CVLT-C Total perseveration and CPR-H scores (r = -.45, p<.001).

None of the EF Test scores was significantly related with WISC-R Verbal IQ score at .01 significance levels. WISC-R Performance IQ score had positive correlation with CVLT-C Short Cued Recall (r = .48, p<.01), while showing negative correlation with STR/5 Errors (r = -.42, p<.01) and CT Duration of Random Shapes (r = -.40, p<.01). WISC-R Full scale IQ was significantly positively related with CVLT-C Short Cued Recall (r =.45, p<.01).

CVLT-C Short Free Recall (r =-.41, p<.01), CVLT-C Total Perseveration (r =-.49, p<.01) and CVLT-C Total Semantic Cluster (r = -.44, p<.01) scores were negatively related with CBCL Internalizing score. There was a significant positive correlation between CBCL Externalizing and Category of Animal-Fruit Perseverative (r = .48, p<.001) score. Meanwhile, significant negative relations were obtained between CVLT-C Short free recall (r =-.42, p<.01), CVLT-C Total Perseveration (r = -.50, p.01) and CBCL Externalizing score.

CBCL Total problem score had negative correlation with CVLT-C Short Free Recall (r = -.49, p<.001), CVLT-C Long Free Recall (r = -.41, p<.01), CVLT-C Total Perseveration (r = -.51, p<.01) and CVLT-C Total Semantic Cluster (r = -.44, p<.01), while having a positive correlation with ToL Total Time Violation (r = .43, p<.01).

Table 15. Control Group's Correlation results of Conner's, Intelligence, Behavior Problems and Executive Functions

	CPR-I	CTR-I	CPR-H	CTR-H	VIQ	PIQ	FSIQ	CBCL Inter.	CBCL Exter.	CBCL Total
Category Persv.	.09	.32	.11	.18	-.26	-.08	-.19	.23	**.48****	**,**38
CVLT-C Total Recall	**-.63*****	**-.41***	-.13	-.05	.25	.22	.27	-.27	-.31	-.37
CVLT-C Short Free Recall	**-.57*****	**-.47****	-.11	-.13	.34	.26	.34	**-.41***	**-.42***	**-.49****
CVLT-C Long Free Recall	**-.51****	-.32	-.19	-.01	.15	.23	.22	-.38	-.27	**-.41***
CVLT-C Short Cued Recall	-.28	-.29	-.02	-.06	.31	**.48***	**.45***	-.08	-.21	-.18
CVLT-C Long Cued Recall	-.27	-.35	-.02	-.14	.35	.32	.38	-.05	-.18	-.14
CVLT-C Total Perseveration	**-.43***	-.25	**-.45****	-.20	-.10	-.28	-.21	**-.49***	**-.50***	**-.51***
CVLT-C Total Semantic Cluster	**-.46***	-.31	-.12	.05	.23	.04	.15	**-.44***	-.39	**-.44***
CVLT-C False Positive	**.53****	.29	-.01	.05	**-**.35	-.25	-.34	.10	.28	.24
CVLT-C Discriminability	**-.53****	-.25	-.04	-.03	.26	.24	.28	-.20	-.30	-.31
STR/5 Time	.06	-.10	**.40***	.28	.08	.07	.08	.07	.34	.22
STR/5 Errors	-.10	-.14	-.00	-.04	-.20	**-.42***	-.37	-.18	-.14	-.13
ToL Total Time Violation	.39	.20	**.41***	.08	-.13	-.27	-.25	.36	.39	**.43***
CT Organized Figures Errors	-.29	-.09	-.01	**.40***	-.05	.13	.06	-.22	-.13	-.19
CT Duration of Random Figures	.20	.00	.02	-.03	-.15	**-.40***	-.33	.02	-.10	-.03
CT Random Figures Errors	.02	-.06	-.10	-.03	-.16	-.23	-.23	-.18	**-.42***	-.24
Bender- Gestalt Test	-.22	**-.42***	.06	-.04	.28	.01	.16	-.35	-.17	-.29

CPR-I: Conner's Parental Rating Scale- Inattentiveness, CTR-I: Conner's Teacher Rating Scale: -Inattentiveness, CPR-H: Conner's Parental Rating Scale- Hyperactivity, CTR-H: Conner's Teacher Rating Scale – Hyperactivity, VIQ: Verbal IQ, PIQ: Performance IQ, FSIQ: Full Scale IQ, CBCL-inter.: Child Behavior Check List Internalizing, CBCL-Exter: Child Behavior Check List Externalizing, CBCL Total: Child Behavior Check List Total Problem, CVLT-C: California Verbal Learning Test for Children, STR: Stroop Test, ToL: Tower of London, CT: Cancellation Task.
***p<.000,**p<.001, *p<.01.

3.4. Comparison of the Groups according to Conner's Parental and Teacher Rating Scales, CBCL and WISC-R scores

Analysis of Conner's Parental and Teacher Rating Scales, CBCL and WISC-R scores were reported separately. In the first heading, analysis of Conner's Parental and Teacher Rating Scales were reported through comparing the four study groups. Under the second heading, CBCL analysis was reported and under the third heading, WISC-R raw and standardized scores were presented by comparing the study groups.

3.4.1. Analysis of Conner's Parental and Conner's Teacher Rating Scales

Conner's Parental Rating Scale – Short Version (CPRS-48), and Conner's Teacher Rating Scale –Short Version (CTRS-28), were used in the aim of collecting multiple sources information on the behavioral symptoms of attention deficit and disruptive (hyperactive/impulsive) behaviors. The cut off point of Conner's rating scales (Dereboy, Şenol, Şener and Dereboy, 2007); for parental rating inattentive scores was 5, and for teacher rating inattentive score was 8. Similarly, cut off point for parental rating hyperactivity score was 6, and for teacher rating hyperactivity score was 7. Results of CPRS-48 and CTRS-28 confirmed the clinical diagnosis of ADHD-I, ADHD-C, and ADHD-Comorbide groups (Table 16).

One-way between subjects ANOVA yielded significant mean difference in Conner's parental rating inattentiveness between the groups [$F(3,143) = 34.06$, $MS_{error} = 7.07$, $p<.001$]. Tukey's post-hoc comparison revealed that Control groups parental inattentiveness scores were significantly lower than the ADHD-I group ($p<.01$), ADHD-C group ($p<.001$), and ADHD-Comorbid group ($p<.001$). There was a significant mean difference between the groups in Conner's parental rating hyperactivity scores [$F(3,143) = 51.31$, $MS_{error} = 15.31$, $p<.001$], and post-hoc comparison revealed that parental rating hyperactivity score was significantly higher for ADHD-C group ($p<.001$), ADHD-Comorbid group ($p<.001$), and ADHD-I group than that for the Control group. In addition, parental rating

hyperactivity score was significantly lower for ADHD-I group than ADHD-C group ($p<.001$) and ADHD-Comorbid group ($p<.001$).

One-way between subjects ANOVA yielded significant mean difference in Conner's teacher rating inattentiveness between the groups [$F(3,143) = 140.70$, $MS_{error} = 16.21$, $p<.001$]. Tukey's post-hoc comparison revealed that Control groups teacher inattentive scores were significantly lower than ADHD-I group ($p<.001$), ADHD-C group ($p<.001$), and ADHD-Comorbid group ($p<.001$). In addition, teacher rating inattentiveness score was significantly lower for ADHD-C group than for the ADHD-I group ($p<.01$), and ADHD-Comorbid group ($p<.001$). Conner's teacher rating of hyperactivity showed significant difference between the groups [$F(3,143) = 55.29$, $MS_{error} = 14.75$, $p<.001$]. Tukey's post-hoc comparison revealed that teacher rating hyperactivity was significantly lower for ADHD-I, and Control groups than for the ADHD-C group ($p<.001$), and ADHD-Comorbid group ($p<.001$).

Table 16. Mean values of Conner's Parental Rating Scale, and Conner's Teacher Rating Scale

	ADHD-I	**ADHD-C**	**ADHD-Comorb.**	**CONTROL**	**F**
	(N= 37)	(N=37)	(N= 37)	(N=36)	**Value**
	M *(SD)*	M (*SD*)	M *(SD)*	M *(SD)*	
CPRS					
Inattentive	7.30b *(2.18)*	7.81b *(2.59)*	8.59b *(3.33)*	2.86a *(2.38)*	**34.06***
Hyperactive	4.76b *(2.24)*	8.46c *(2.53)*	8.57c *(2.20)*	3.11a *(2.21)*	**51.31***
CTRS					
Inattentive	11.30c *(4.86)*	8.30b *(3.69)*	12.70c *(4.52)*	3.08a *(2.63)*	**40.70***
Hyperactive	4.78a *(3.04)*	12.11b *(3.75)*	13.19b *(4.78)*	4.28a *(3.57)*	**55.29***

CPRS: Conner's Parental Rating Scale, **CTRS:** Conner's Teacher Rating Scale
*$p<.001$

3.4.2. Analysis of Child Behavior Check List (CBCL)

One-way analysis of variance (One-way ANOVA) between subject design was used to test the mean differences of the four study groups in the problem behavior and syndrome score of CBCL. When significant F value was obtained, the groups were compared with Tukey's post-hoc test to evaluate significant differences between the groups.

There were one outlier in CBCL Total variable (Z=3.32), and deleted, and homogeneity of variance test (Levene test) indicated the normality of distribution.

Table 17 is presenting mean difference of CBCL scores between the four study groups. Significant group differences were obtained in all CBCL problem scores. Four Total Problem score was significantly differ between the groups [F (3,142) = 23.14, MS_{error} = 66.26, p<.000]. Comparison results of Tukey test showed that ADHD-Comorbid group was significantly higher than Control Group (p<.001), and ADHD-I (p<.001) while there weren't any significant differences between ADHD-Comorbid and ADHD-C, and ADHD-I and ADHD-C. Internalizing problem score of ANOVA results yielded a significant difference between the four groups [F(3,143) = 8.15, MS_{error} = 73.82, p<.000). Tukey post-hoc test indicated that Control group had significantly lower internalizing problem score than ADHD-I group (p<.000), ADHD-C group (p<.002) and ADHD-Comorbid group (p<.001). Externalizing problem scores significantly differed between the groups [F(3,143) = 27.17, MS_{error} = 85.12, p<.000]. Concerning post-hoc comparison of the group differences; control group had significantly lower scores than the ADHD-I group (p<.000), ADHD-C group (p<.000) and ADHD-comorbid group (p<.000). In addition, ADHD-I group had less externalizing problem than ADHD-Comorbid group (p<.000), while didn't significantly differ than ADHD-C. On the other hand, there weren't any significant group differences between ADHD-C and ADHD-Comorbid groups concerning externalizing problems

All syndrome scores were significantly lower for Control group. Withdrawn score was significantly different between the groups [F(3,143) = 3.50, MS_{error} = 68.11, p<.05]. Tukey post-hoc comparison indicated that withdrawn score of the

control group was significantly lower than ADHD-I group ($p<.01$), while no significant difference was observed between the other groups. Somatic complain scores significantly varied between groups [$F(3,143) = 4.15$, $MS_{error} = 60.85$, $p<.01$], group comparison analyses revealed that somatic complaints of the control group significantly lower than ADHD-I ($p<.01$) and ADHD-C ($p<.02$) groups. There was a significant difference between the groups in anxiety/depression scores [$F(3,143) = 5.40$, $MS_{error} = 72.70$, $p<.01$], and group comparison indicating that anxiety/depression score of the Control group significantly lower than ADHD-I group ($p<.01$), ADHD-C group ($p<.02$) and ADHD-Comorbid group ($p<.01$).

ANOVA result revealed that social problems score significantly varied between the groups [$F(3,143) = 13.60$, $MS_{error} = 72.84$, $p<.000$], and social problems of ADHD-comorbid group significantly higher than control group ($p<.000$), ADHD-C group ($p<.01$). and ADHD-I group ($p<.02$). In addition control group significantly differed than ADHD-I group ($p<.02$), and ADHD-C group ($p<.05$). Analysis of thought problems indicated significant group differences [$F(3,143) = 6.42$, $MS_{error} = 61.26$, $p<.000$], and post-hoc group comparison revealed that thought problems score of control group significantly lower than ADHD-I group ($p<.03$), ADHD-C group ($p<.01$) and ADHD-Comorbide group ($p<.001$). Attention problem score had significant differences between the groups [$F(3,143) = 27.14$, $MS_{error} = 64.29$, $p<.000$]. According to Tukey post-hoc test analysis attention problem score of control group significantly lower than ADHD-I group ($p<.000$), ADHD-C group ($p<.000$), and ADHD-Comorbid group ($p<.000$). Other three clinical group didn't significantly differ than each other. Score of delinquent behavior was significantly different between groups [$F(3,143) = 10.71$, $MS_{error} = 58.20$, $p<.000$], and group comparison indicated that ADHD-Comorbid group had significantly more delinquent problem than ADHD-I group ($p<.01$) and control group ($p<.000$), whereas control group's delinquent problem score significantly lower than ADHD-C group ($p<.01$). There was a significant group differences in aggressive behavior score [$F(3,143) = 19.93$, $MS_{error} = 88.44$, $p<.000$]. Tukey post-hoc group comparison indicated that, the level of aggressive behavior problem was

significantly lower for the control group than ADHD-I group (p<.05), ADHD-C group (p<.000) and ADHD-Comorbid group (p<.000). In addition, aggressive behavior problem of ADHD-Comorbid group was significantly higher than ADHD-I group (p<.000), and ADHD-C group (p<.05).

Table 17. Mean values of Child Behavior Check List (CBCL)

	ADHD-I (n=37)	**ADHD-C (n=37)**	**ADHD-Comorb. (n=37)**	**CONTROL (n=35)**	
	M *(SD)*	M (*SD*)	M *(SD)*	M *(SD)*	**F**
Total	64.35b (8.26)	66.95bc (7.12)	69.92c (7.42)	54.77a (9.61)	**23.14*** **
Internalizing	66.03b (8.00)	64.51b (9.05)	65.19b (7.64)	57.19a (9.57)	**8.15*** **
Externalizing	58.35b (9.66)	63.27bc (8.16)	68.11c (9.23)	49.44a (9.78)	**27.17*** **
Withdrawn	62.64b (7.72)	59.68ab (9.35)	61.03ab (8.98)	56.11a (6.65)	**3.50***
Somatic	60.65b (9.28)	60.22b (7.91)	59.57ab (7.52)	54.94a (6.13)	**4.15****
Anx/Depres.	65.97b (8.13)	65.14b (9.82)	65.84b (7.83)	59.11a (8.17)	**5.40****
Social Prob.	60.14b (8.22)	59.73b (7.30)	66.78c (10.84)	54.06a (7.24)	**13.60*** **
Thought Prob.	61.81b (7.76)	63.43b (8.81)	63.86b (7.43)	56.69a (7.19)	**6.42*** **
Attention Problem	67.03b (7.77)	70.54b (7.90)	71.65b (8.93)	56.44a (7.38)	**27.14*** **
Delinquent	57.78ab (7.42)	60.19bc (8.21)	63.49c (9.43)	53.67a (4,51)	**10.71*** **
Aggressive	60.22b (9.83)	64.43b (9.38)	70.46c (11.56)	53.97a (5.85)	**19.93*** **

***p<.000, **p<.001, *p<.01

3.4.3. Analysis of Wechsler Intelligence Scale for Children-Revised (WISC-R)

Before running one-way between subjects ANOVA analysis, outliers was checked. Digit span in row scores and standardized comprehension score indicated distorted normality. Z value was gathered for these variables and 3 subjects from digit span (two from ADHD-I group, and one from control group) deleted. Concerning comprehension score, 3 subjects were deleted; one from ADHD-C and

one from two from ADHD-I group, and after deleting the outliers Levenes' test wasn't significant.

Results of one-way between subjects ANOVA WISC-R scores were presented in Table 18. Both raw scores and standardized scores of WISC-R were analyzed in the aim of getting clear picture of the mean differences as transferring the standardized scores might decrease the differences. Firstly, raw scores outcome was reported. Verbal subtest of information had significant difference between the groups [$F(3,143) = 2.81$, $MS_{error} = 26.20$, $p<.05$]. Consequently, the groups were compared with Tukey's post-hoc test, but no significant group difference was observed. Because Tukey is a more "conservative" test, Duncan post-hoc comparison test was used to compare groups. Duncan post-hoc test indicated that ADHD-I group had significantly better performance than ADHD-C ($P<.05$) and ADHD-Comorbid group ($p<.05$).

ANOVA analysis yielded significant difference between the groups in arithmetic subtest [$F(3,143) = 4.27$, $MS_{error} = 7.45$, $p<.01$], and Tukey's post-hoc test indicated that subjects in ADHD- I group had significantly higher score than subjects in ADHD-C group ($p<.05$). Comprehension subtest had significant group difference in ANOVA analyses [$F(3,141) = 3.76$, $MS_{error} = 17.69$, $p<.01$], and comparison of groups revealed that the ADHD-I group was significantly better than ADHD-C group ($p<.05$) and ADHD-Comorbid group ($p<.05$). Concerning to Performance Subtest raw scores; picture completion [$F(3,143) = 3.34$, $MS_{error} = 14.78$, $p<.05$] and Mazes [$F(3,143) = 2.98$, $MS_{error} = 29.07$, $p<.05$] scores showed significant differences between the groups. Tukey's post-hoc comparison results did not indicate any difference between the groups in accordance to Mazes subtest score. However, Duncan post-hoc test revealed that ADHD-Comorbid group was significantly worse than ADHD-I group ($p<.05$), and Control group ($p<.05$) in the subtest of mazes. On the other hand, ADHD-I group had significantly better performance than ADHD-C group ($p<.05$) in the picture completion subtest. Raw score of Verbal IQ had significant difference between the groups [$F(3,143) = 3.14$, $MS_{error} = 74.02$, $p<.05$]. Tukey's post-hoc comparison revealed that in raw Verbal

IQ score, subjects in control group were significantly better than the subjects in ADHD-Comorbid group ($p<.05$).

Table 18. Mean values of WISC-R Scores.

	Row Scores of WISC-R					Standardized Scores of WISC-R				
	ADHD-I (n=37)	**ADHD-C (n=37)**	**ADHD-Comr. (n=37)**	**Control (n=36)**	**F Value**	**ADHD-I (n=37)**	**ADHD-C (n=37)**	**ADHD-Comr. (n=37)**	**Control (n=36)**	**F Value**
	M (SD)	M (SD)	M (SD)	M (SD)		M (SD)	M (SD)	M (SD)	M (SD)	
Verbal Subtests										
Information	**13.86b (5.45)**	**10.94a (5.31)**	**11.30a (4.65)**	**13.14ab(5.00)**	**2.81***	8.13 (2.98)	7.84 (2.54)	7.76 (2.34)	9.19 (2.66)	2.28
Similarities	14.14 (5.13)	12.92 (4.95)	12.11 (5.15)	14.22 (5.20)	1.45	11.43 (2.72)	12.08 (2.84)	11.41 (2.98)	12.58 (2.18)	1.60
Arithmetic	**11.91b (3.09)**	**10.08a (2.5)**	**10.32ab(2.67)**	**11.67ab(2.66)**	**4.27****	9.92 (2.93)	9.35 (2.41)	9.70 (3.05)	10.97 (2.36)	2.41
Comprehension	**20.68b (4.35)**	**18.03a(4.02)**	**18.03a (4.59)**	**19.89ab(3.74)**	**3.76****	**12.59ab(3.00)**	**11.81a (1.98)**	**11.81a (2.16)**	**13.17b (1.98)**	**2.95***
Vocabulary	38.08 (10.49)	32.27(12.62)	33.24 (12.11)	35.59 (11.16)	1.82	10.08 (2.25)	10.77 (2.66)	10.76 (2.77)	11.08 (2.16)	1.06
Digit Span	9.89 (2.97)	8.78 (3.17)	8.76 (1.95)	10.11 (2.99)	2.35	9.76 (3.22)	9.65 (2.53)	9.32 (2.58)	10.75 (2.72)	1.78
Performance Sub										
Picture Completion	**15.95b (4.22)**	**13.35a(3.69)**	**13.86ab(3.24)**	**13.83ab(4.15)**	**3.34***	11.22 (2.56)	9.97 (2.53)	10.27 (2.31)	10.25 (2.81)	1.67
Picture Arrangement	20.68 (7.87)	17.89 (8.29)	16.78 (8.83)	19.42 (7.04)	1.66	10.19 (2.07)	10.54 (3.23)	9.97 (3.12)	10.86 (2.64)	0.71
Block Designs	21.95 (12.30)	15.97(10.80)	15.73 (9.89)	18.63 (12.57)	2.38	10.92 (3.17)	10.30 (2.94)	10.16 (2.50)	10.92 (2.99)	0.70
Object Assembly	15.41 (5.99)	14.41 (5.79)	14.65 (5.39)	14.00 (5.53)	0.40	10.70 (2.94)	11.22 (2.57)	11.49 (3.16)	10.94 (2.53)	0.54
Coding	36.54 (9.68)	35.27 (9.79)	33.67 (8.59)	36.11 (8.89)	0.69	9.81 (2.18)	10.65 (3.22)	10.03 (2.65)	10.86 (2.31)	1.32
Mazes	**19.64b (6.19)**	**17.35ab(5.11)**	**16.70a (4.58)**	**19.64b (5.57)**	**2.28***	**11.08ab (2.66)**	**10.73ab (2.60)**	**10.36a (2.95)**	**12.36b (3.32)**	**3.25***
Verbal Intelligence	**52.19ab(8.97)**	**52.19ab8.04**	**51.54a 9.18**	**57.00b 8.16**	**3.14***	**102.95ab(12.18)**	**102.97ab(10.96)**	**102.05a(12.41)**	**109.44b(11.04)**	**3.12***
Performance Intelligence	52.86 (8.31)	52.62 (9.40)	51.73 (8.52)	53.86 (9.22)	0.36	103.81 (12.19)	103.78 (13.26)	102.27 (12.06)	105.61 (13.28)	0.42
Full Intelligence	104.78(14.69)	102.27(21.57)	103.22(15.00)	111.06(15.13)	2.00	103.57 (11.23)	103.62 (11.43)	102.32 (11.40)	108.31 (11.63)	1.93

***p<.001, **p<.01, * p<.05.

Secondly, standardized WISC-R scores analyzed. Comprehension (Verbal Subtest) was significantly different between the groups [F (3,143) = 2.98, MS_{error} = 4.74, p<.05]. Tukey's post-hoc comparison revealed that subjects in the control group had higher scores than subjects in the AHDH-C group (p<.05). Mazes, a performance subtest was significantly different between the groups [F (3,143) = 3.25, MS_{error} = 8.39, p<.05]. Post-hoc analyses result yielded that subject in control group significantly better than subjects in ADHD-Comorbid group (p<.05) in subtest of mazes. Same as raw score Verbal IQ, standardized Verbal IQ score also had significant group differences [F (3,143) = 3.12, MS_{error} = 136.15, p<.05], and post hoc comparison of groups indicated that Verbal IQ score of control group was significantly higher than ADHD-Comorbid group (p<.05). Rest of the raw subtest and standardized subtest scores didn't show any significant difference between the groups.

3.4.3.1. Digit Span Forward, Digid Span Backward, Freedom from Distractibility (Arithmetic, Digid Span, Coding), and ACID (Arithmetic, Coding, Information, Digid Span)

Combination of WISC-R subtests were used to discriminate children with ADHD from normal control. In this section, connecting with WISC-R outcome, different combination of WISC-R subtests such as digit span forward, digit span backward, distractibility (arithmetic + digit span + coding), and ACID (arithmetic + coding + information + digit span) was reported for comparing ADHD children with normal sample.

There were not outliers, and none of the subjects were excluded. One-way between subject ANOVA yielded significant group differences in digit span backward [F (3,143) = 5.03, MS_{error} = 2.80, p<.01], and Tukey's post-hoc group comparison indicated subjects in inattentive group repeated significantly more numbers in backwards than subjects in ADHD-C group (p<.02) and subjects in ADHD-Comorbid group (p<.01) (Table 19). There was a significant group difference between groups in distractibility score [F (3,143) = 2.98, MS_{error} = 23.22, p<.05]. Post-hoc group comparison indicated that the subjects in the Control group

significantly better than the subjects in ADHD-Comorbid group (p<.05). ACID as composed of WISC-R subtests had significant mean differences between the groups [F (3,143) = 3.41, MS_{error} = 43.25, p<.05]. Group comparison of post-hoc test revealed that Control group had significantly better performance than ADHD-C group (p<.05) and ADHD-Comorbid group (p<.05).

Table 19. Mean values of Digit Span Forward-Backward, Distractibility, and ACID

	ADHD-I (n=36)	ADHD-C (n=36)	ADHD-Comor. (n=37)	Control (n=36)	F Value
Digid Span Forward	5.95 (2.04)	5.49 (2.17)	5.27 (1.57)	5.78 (1.79)	0.92
Digid Span Backward	4.70b (2.07)	3.54a (1.46)	3.46a (1.26)	4.39ab (1.79)	**5.03****
Freedom From Distractibility	22.95ab(5.49)	22.55ab (3.88)	22.37a (5.08)	25.34b (4.67)	**2.98***
ACID	30.30ab(6.26)	30.25ab (5.49)	29.82a (6.92)	33.72b (5.51)	**3.21***

ACID: Arithmetic+ Coding + Information + Digid Span
**p<.01, *p<.05

3.5. Comparison of the Groups according to Executive Function Tests / Tasks

3.5.1. Tower of London (ToL^{DX})

Outliers were checked for all ToL variables. Two subjects (from ADHD-I group) were deleted from the number of correct responses, and one subject (ADHD-C group) was deleted from Type I error variable. Levenes test, indicated normality of variances for all variables.

Numbers of correct responses [F (3,141) = 2.84, MS_{error} = 1.54, p<.05], Number of total moves [F (3,143) = 5.13, MS_{error} = 269.75, p<.01], and Total Initiation Time [F (3,143) = 3.21, MS_{error} = 667.06, p<.05] scores of ToL^{DX} Task were significantly different between groups. Ad-Hoc comparison revealed that Control group's number of correct responses was significantly higher than the ADHD-Comorbid group (p<.05). ADHD-C group (p<.01) and ADHD-Comorbid

group (p<.01) number of total moves scores were significantly higher than that of the Control group. Control group's total initiation time score was significantly higher than that of the ADHD-Comorbid group (p<.05).

Table 20 is presenting One-Way between subject ANOVA results of Tower of London (ToL^{DX}):

Table 20. Mean values of Tower of London

	ADHD-I	**ADHD-C**	**ADHD-Comor.**	**Control**	**F Value**
	M (SD)	M (SD)	M (SD)	M (SD)	
(ToL^{DX})	**(n= 35)**	**(n=37)**	**(n=37)**	**(n=36)**	
Num. of Correct Responses	3.23ab (1.42)	2.95ab (1.27)	2.54a (1.02)	3.31b (1.24)	**2.84***
	(n=37)	**(n=37)**	**(n=37)**	**(n=36)**	
Number of Total Moves	40.46ab (18.76)	47.68b (18.02)	49.30b (15.38)	36.19a (12.77)	**5.13****
Total Initiation Time	42.08ab (31.61)	39.54ab (29.82)	26.89a (12.27)	43.64b (25.06)	**3.21***
Total Execution Time	360.05 (185.63)	409.73 (178.98)	391.11 (169.47)	349.64 (120.08)	1,02
Total Problem-Solving Time	402.14 (190.17)	450.05 (186.30)	417.81 (175.73)	393.19 (132.47)	0.77
Number of Total Time Violation	2.27 (1.95)	2.57 (1.71)	2.24 (1.77)	1.89 (1.55)	0.92
	(n=37)	**(n=36)**	**(n=37)**	**(n=36)**	
Type I Errors	0.62 (0.98)	1.03 (1.16)	0.94 (1.08)	0.58 (0.77)	1.78
Type II Errors	1.24 (1.92)	1.51 (1.89)	1.43 (1.64)	0.97 (1.23)	0.73

**p<.01, *p<.05

3.5.2. Wisconsin Card Sorting Test (WCST)

Before applying One-way ANOVA, outliers were checked for all WCST variables. Only two variables had outliers: number of total responses, and trails to complete first category. Z value of these variables indicated that five subjects scored as outliers in the control group. They completed the test with less response cards, which was one of the assumptions of the study. Therefore outliers remained. The second outlier group consisted of subjects of ADHD-Comorbid group; in the

same variable as before, this time, worse performance, in other words excessive card using for completing first category was observed in two subjects. It was concordant with the assumption of study; the outliers were not excluded.

One-way between subject ANOVA used to analyze differences in the WCST scores between the groups, and after revealing significant mean differences between the groups, Tukey's post-hoc test was used to compare groups. Outcome of analysis is displayed in Table 21.

Significant differences were found for the number of total responses [$F(3,143) = 3.35$, $MS_{error} = 129.74$, $p<.05$], number of errors [$F(3,143) = 5.75$, $MS_{error} = 310.84$, $p<.001$], total number of correct responses [$F(3,143) = 2.91$, $MS_{error} =197.31$, $p<.05$], number of categories completed [$F(3,142) = 2.97$, $MS_{error} = 2.61$, $p<.05$], perseverative errors [$F(3,143) = 3.34$, $MS_{error} = 266.43$, $p<.05$], and percent of conceptual level responses [$F(3,143) = 4.33$, $MS_{error} = 270.20$, $p<.01$]. Tukey's Ad-Hoc comparison yielded that the number of total response score was significantly higher for ADHD-Combined group than for the control group ($p<.05$), while no significant difference was observed between Control group and ADHD-I group. Total number of errors was significantly higher for ADHD-C ($p<.01$), and ADHD-Comorbid groups ($p<.001$) than for the control group; meanwhile there were no significant differences between ADHD-I group and Control group, ADHD-I and ADHD-C, ADHD-I and ADHD-Combined group. Concerning number of correct responses, ad-hoc comparison of Tukey did not yield significant differences between the groups, and Duncan post-hoc comparison was used and outcome of the analyses indicated that Control group had significantly more correct responses than ADHD-I group, ADHD-C group and ADHD-Comorbid group ($p<.05$). More categories were completed by the control group and significant difference was observed between control group and ADHD-Comorbid group ($p<.05$). As it was mentioned earlier, percentage of conceptual level responses were significantly different between the groups, and Tukey's post-hoc comparison indicated that the control group had significantly higher scores than ADHD-C ($p<.05$) and ADHD-Comorbid ($p<.01$) groups.

Table 21. Mean values of Wisconsin Card Sorting Test

	ADHD-I (n=37)	ADHD-C (n=37)	ADHD-Comr. (n=37)	Control (n=36)	F Value
	M (SD)	M (SD)	M (SD)	M (SD)	
Number of Total Responses	121.57ab(15.60)	125.41ab (6.90)	127.46b (2.52)	119.94a (4.96)	**3.35***
Total Number of Errors	53.54ab (20.91)	59.51b (16.41)	61.92b (15.82)	46.25a (16.91)	**5.73****
Total Number of Correct Responses	66.41a (17.14)	65.68a (12.80)	65.54a (14.87)	73.81b (10.39)	**2.92***
Number of Categories Completed	3.83ab (1.63)	3.54ab (1.74)	3.08a (1.50)	4.17b (1.58)	**2.97***
Perseverative Responses	34.03 (19.05)	42.03 (24.42)	40.86 (21.53)	30.14 (20.59)	2.53
Perseverative Errors	29.57ab (15.36)	35.27b (17.64)	34.14ab (16.40)	24.42a (15.79)	**3.34***
Non-Perseverative Errors	23.62 (11.78)	24.68 (11.50)	27.68 (12.27)	22.31 (11.47)	1.39
Perseverative Errors (%)	25.87 (15.46)	28.05 (13.35)	27.16 (12.47)	20.97 (11.85)	2.03
Trails to Complete First Category	19.61 (18.98)	24.59 (19.06)	21.08 (16.85)	18.28 (10.84)	0.96
Conceptual Level Resp. (%)	44.94ab 18.72)	39.35a (15.61)	37.54a (14.84)	50.03b (16.40)	**4.33****
Failure to Maintain Set	1.14 (1.05)	1.14 (1.16)	1.43 (1.86)	1.36 (1.46)	0.43

***p>.001, **p<.01, *p<.05

3.5.3. Verbal Fluency Test (K-A-S) and Category Fluency Test (Animal-Fruit)

There were two outliers (one from ADHD-I, one from Control group) in K-A-S scores concerning the Z values, and they were excluded. Mean values of Verbal Fluency and Category Fluency Test results were presented at Table 22.

There were no significant difference between the groups in verbal fluency (K-A-S), perseverative errors of K-A-S, and Category fluency test scores. On the other hand, significant group differences were observed in the category perseverative errors between the groups [$F(3,141) = 5.52$, $MS_{error} = 0.79$, $p<.001$]. Post-Hoc Comparison revealed that category perseveration (being unable to change categories and continuing with previous ones) of ADHD-C group was significantly higher than Control ($p<.01$), and ADHD-I ($p<.01$) groups.

Table 22. Mean values of K-A-S and Category Fluency Test

	ADHD-I	ADHD-C	ADHD-Comor.	Control	F Value
	M (SD)	M (SD)	M (SD)	M (SD)	
	(n=35)	**(n=36)**	**(n=37)**	**(n=35)**	
Verbal Fluency (K-A-S)	18.89 (6.95)	15.61 (7.78)	15.05 (5.87)	17.94 (9.25)	1.98
	(n=36)	**(n=36)**	**(n=37)**	**(n=36)**	
K-A-S Perseverative	0.03 (0.17)	0.00 (0.00)	0.81 (0.36)	0.06 (0.33)	0.65
Category Fluency (Animal-Fruit)	5.17 (1.42)	4.67 (1.76)	4.57 (2.01)	5.14 (1.66)	1.19
Category Perseverative	0.14a (0.35)	0.89b (1.41)	0.35ab (0.86)	0.17a (0.56)	**5.52*****

***p<.001

3.5.4. California Verbal List Test for Children (CVLT-C)

Variables of long free recall, total perseveration, recognition hits, discriminability and false positive had outliers. Outliers were assessed via Z value, and subjects who had higher / lower values than 3.27, respectively -3.27 were excluded. There wasn't any difference in significance level after excluding outliers. In other words, outliers didn't cause Type I error; therefore they remained in analysis.

One-Way between subject ANOVA analyses yielded significant mean difference in total recall list A [$F(3,143) = 5.75$, $MS_{error} = 66.66$, $p<.001$], and post hoc pairwise comparison indicated that the ADHD-I and Control group performed significantly better than ADHD-C group ($p<.01$, $p<.01$ respectively) and ADHD-Comorbid group ($p<.05$, $p<.05$ respectively). Short delay free recall had significant difference between the groups [$F(3,143) = 4.61$, $MS_{error} = 6.95$, $p<.01$]. Tukey's ad-hoc comparison revealed that short delay free recall performance of control group was significantly better than ADHD-C ($p<.01$), and ADHD-Comorbid ($p<.05$) group. There are significant mean difference between the groups in long delay free recall [$F(3,143) = 4.53$, $MS_{error} = 8.26$, $p<.01$], and long delay cued recall [$F(3,143) = 3.67$, $MS_{error} = 7.03$, $p<.05$]. The control group performed significantly better than ADHD-Comorbid group for long delay free recall ($p<.05$)

and long delay cued recall ($p<.05$) tasks. Significant group difference was observed in total intrusion [$F(3,143) = 2.79$, $MS_{error} = 56.36$, $p<.05$], and Tukey's post-hoc comparison indicated that total intrusion score of ADHD-Comorbid group was significantly higher than control group ($p<.05$). Short delay cued recall had significant mean differences between the four groups [$F(3,143) = 2.54$, $MS_{error} = 7.13$, $p<.05$]. Since, post-hoc comparison of Tukey did not yield significant differences between the groups, Duncan post-hoc test was conducted. The results indicated that the Control group had significantly better performance than the ADHD-Comorbid group ($p<.05$). One-way between subjects ANOVA yielded a significant difference between the four groups in terms of the total semantic cluster scores, [$F(3,143) = 5.07$, $MS_{error} = 57.25$, $p<.01$], and the mean total semantic cluster of the control group was significantly higher than ADHD-C ($p<.05$) and ADHD-Comorbid ($p<.05$) groups. Scores of the correct recognition hits were significantly different between the groups [$F(3,143) = 5.05$, $MS_{error} = 2.82$, $p<.01$], and post-hoc comparison revealed that the control group had significantly higher correct recognition hits score than ADHD-C ($p<.001$) group. There was significant mean differences between the four groups on the percentage of discriminability scores, [$F(3,143) = 4.46$, $MS_{error} = 51.88$, $p<.01$]. Post-hoc comparison indicated that the discriminability score of the control group was significantly higher than ADHD-C group ($p<.05$). Concerning score of false positives, significant mean differences were obtained [$F(3,143) = 2.71$, $MS_{error} = 5.07$, $p<.05$], and Duncan pairwise comparison reveal that subjects in ADHD-Comorbid group had significantly more false positive recognition hits than Control ($p<.05$) group (Table 23).

Table 23. Mean values of California Verbal List for Children

	ADHD-I		ADHD-C		ADHD-Comor.		Control		F
	M	(SD)	M	(SD)	M	(SD)	M	(SD)	Value
	(n=37)		(n=37)		(n=37)		(n=36)		
Total Recall List A	47.13b	(8.00)	41.27a	(8.10)	42.14a	(8.95)	47.39b	(7.51)	**5.75*** **
Short Delay Free Recall	9.57ab	(2.72)	8.08a	(3.08)	8.32a	(2.57)	10.0b	(2.06)	**4.61** **
Long Delay Free Recall	10.08ab	(2.62)	8.54ab	(3.59)	8.35a	(2.95)	10.22b	(2.10)	**4.35** **
Short Delay Cued Recall	9.11ab	(2.73)	8.51ab	(2.80)	8.08a	(2.77)	9.69b	(2.35)	**2.54***
Long Delay Cued Recall	9.49ab	(2.91)	8.51ab	(2.78)	8.11a	(2.69)	9.92b	(2.16)	**3.67***
Total Perseveration	5.35	(3.27)	6.86	(4.42)	8.11	(6.07)	7.97	(5.96)	2.34
Total Intrusion	5.97ab	(7.37)	7.65ab	(6.60)	9.70b	(8.81)	4.97a	(7.06)	**2.79***
Total Semantic Cluster	22.05ab	(8.25)	17.49a	(7.37)	17.76a	(7.72)	22.86b	(6.82)	**5.07** **
Correct Recognition Hits	13.41ab	(1.46)	12.64a	(2.36)	13.24ab	(1.67)	14.17b	(0.85)	**5.05** **
Discriminability (%)	95.27ab	(4,71)	91.38a	(9.15)	91.89a	(8.79)	96.50b	(4.85)	**4.46** **
False Positivies	0.70ab	(1.27)	1.57ab	(2.41)	1.97b	(3.01)	0.81a	(1.94)	**2.71***

***p<.001, **p<.01, *p<.05

3.5.5. Continuous Performance Test (CPT) and Go-No-Go Task

Analysis of outliers in terms of Continuous Performance Test and Go-No-Go Test indicated that there was just one outlier in CPT commission error variable in ADHD-C group, and the subject was excluded from the statistical analyses of CPT commission error.

One-Way between subject ANOVA analyses revealed no significant difference between the groups concerning total correct responses [$F(3,143) = 2.15$, $MS_{error} = 38.60$, $p>.05$] and omission errors [$F(3,143) = 2.18$, $MS_{error} = 38.60$, $p>.05$] of CPT. On the other hand, commission errors of CPT score were significantly different in the groups [$F(3,142) = 4.74$, $MS_{error} = 117.7$, $p<.01$]. Post hoc pairwise comparison indicated that the mean CPT commission errors score of ADHD-Comorbid group was significantly higher than Control ($p<.01$) and ADHD-I ($p<.05$) groups.

Concerning Go-No-Go task, no significant mean differences were observed between the groups in the Go-No-Go total correct responses scores [F (3,143) = 0.55, MS_{error} = 120.80, p>.05], Go-No-Go omission errors [F (3,143) = 0.58, MS_{error} = 120.79, p>.05], and Go-No-Go commission errors [F (3,143) = 0.18, MS_{error} = 79.98, p>.05] as it is shown in Table 24.

Table 24. Mean values of Continuous Performance Test and Go-No-Go Test

	ADHD-I	**ADHD-C**	**ADHD-Comor.**	**Control**	**F Value**
	M (SD)	M (SD)	M (SD)	M (SD)	
Continuous Performance Test (CPT)	**(n=37)**	**(n=37)**	**(n=37)**	**(n=36)**	
Total Correct Responses	47.62 (6.07)	45.70 (6.46)	44.32 (7.23)	47.19 (4.81)	2.16
CPT Omission Errors	6.35 (6.07)	8.30 (6.46)	9.68 (7.23)	6.81 (4.81)	2.18
	(n=37)	**(n=36)**	**(n=37)**	**(n=36)**	
CPT Commission Errors	11.11a (12.80)	16.83ab (13.82)	20.24b (17.00)	10.14a (8.03)	**4.74****
Go-No-Go Task	**(n=37)**	**(n=37)**	**(n=37)**	**(n=36)**	
Total Correct Responses	45.24 (10.78)	42.73 (11.36)	42.19 (11.11)	43.06 (10.69)	0.55
Go-No-Go Omission Errors	14.68 (10.78)	17.27 (11.36)	17.81 (11.11)	16.94 (10.69)	0.58
Go-No-Go Commission Errors	12.70 (8.93)	12.86 (8.88)	13.86 (8.77)	12.44 (9.19)	0.18

*p<.05

3.5.6. Stroop Color Word Test (STR)

Three subjects (one from ADHD-C group and two from ADHD-Comorbid group) were determined as outliers. In three variables (STR/1, STR/2, and STR/3) same subjects had extreme values and they were excluded from the analysis of the Stroop test. One subject (ADHD-Comorbid group) could not complete the Stroop test, therefore ADHD-Comorbid group was consisted of 34 children after excluding 2 outliers. One-way between subjects ANOVA results were applied to assess significant mean differences between the groups.

In general ADHD-Comorbid group had higher scores in all subtests of Stroop test (Table 25), consequently, time of reading plain letters (STR/1) scores, reading colored letters (STR/2) scores, and naming the colored shapes (STR/3) scores , [$F(3,139) = 2.82$, $MS_{error} = 62.60$, $p<.05$], revealed significant differences between the groups. Significant difference between four groups in STR-1 (reading plain letters) score [$F(3,139) = 4.76$, $MS_{error} = 39.99$, $p<.01$], was assessed comparing the groups by Tukey's post-hoc test, and ADHD-Comorbid group had significantly worse performance than ADHD-I ($p<.01$) and Control group ($p<.01$) in terms of duration time of reading plain words. Revealing significant mean differences between four groups in reading colored letters [$F(3,139) = 2.57$, $MS_{error} = 32.55$, $p<.05$], Tukey's pos-hoc comparison test was applied in the aim of assessing group differences, and the outcome indicated that performance of Control group was significantly better than ADHD-Comorbid group ($p<.05$). Even though One-way ANOVA revealed significant mean difference for naming the colored shapes scores, outcome of Tukey's pairwise comparison did not indicate any significant difference between the groups. However, according to Duncan post-hoc comparison, ADHD-Comorbid group was significantly slower than ADHD-I group ($p<.05$) and Control group ($p<.05$) for naming color of shapes. Difference in naming color of colors (STR/5) score was statistically significant between the groups [$F(3,142) = 2.58$, $MS_{error} = 486.10$, $p<.05$]. Group comparison of naming color of colors (STR/5) showed not significant difference in Tukey post-hoc test. But the additionally applied Duncan post-hoc test revealed significant differences between the groups; and the Control group had better performance than ADHD-Comorbid group ($p<.05$).

In addition, Total Stroop duration time and Stroop interference effect (STR/5 - STR/4) were analyzed. Total Stroop duration time was significantly different between the groups [$F(3,139) = 3.35$, $MS_{error} = 1978.16$, $p<.05$]. Pairwise comparison indicated that the ADHD-Combined group performed significantly poorer than Control group. There wasn't any significant difference between the groups in the Stroop interference effect [$F(3,139) = 2.19$, $MS_{error} = 203.68$, $p>.05$].

Table 25. Mean Values of Stroop Test

	ADHD-I (n=37)	ADHD-C (n=36)	ADHD-Comor. (n=34)	Control (n=36)	F Value
	M (SD)	M (SD)	M (SD)	M (SD)	
STROOP					
STR/1 Plain Letters	11.62a (2.99)	13.67ab (4.58)	16.47b (11.41)	11.47a (2.43)	**4.76****
STR/2 Colored Letters	14.19ab (6.12)	14.69ab (5.39)	16.47b (7.09)	12.72a (3.77)	**2.57***
STR/3 Colored Shapes	19.21a (5.75)	22.78ab (10.26)	23.59b (9.08)	19.53a (5.62)	**2.82***
STR/4 Naming Color of Words	31.65 (11.80)	35.89 (12.43)	36.53 (14.24)	37.72 (11.64)	1.29
STR/5 Naming Color of Colors	50.37a (21.39)	55.86ab (21.42)	60.65b (24.79)	48.19a (18.50)	**2.58***
STR/5 Errors	1.19 (2.12)	0.89 (1.33)	1.82 (2.15)	1.28 (2.24)	1.33
STR/5 Correction	2.43ab (1.86)	2.39ab (1.95)	3.00b (1.92)	1.36a (1.48)	**5.01****
Total Stroop Time	127.05ab (38.91)	142.89ab(48.18)	153.71b (52.04)	124.64a(37.74)	**3.35***
Stroop Interference	18.73 (15.14)	19.97 (13.00)	24.12 (17.33)	15.47 (10.99)	2.19

**p<.01, *p<.05

3.5.7. Trail Making Tests (TMT) and Bender-Gestalt Test

Outlier analysis revealed that 3 subjects had excessively high scores in Trail Making B errors. After excluding outliers, homogeneity of variance was satisfied. One-way between subjects ANOVA carried out to assess mean differences between the four groups.

Outcome of one-way ANOVA revealed no significant differences for the progression time of TMT A [$F(3,143) = 1.28$, $MS_{error} = 3282.19$, $p>.05$] and TMT B [$F(3,143) = 1.32$, $MS_{error} = 11325.91$, $p>.05$]. Errors of TMT A [$F(3,143) = 0.34$, $MS_{error} = 0.12$, $p>.05$] and TMT B [$F(3,140) = 1.45$, $MS_{error} = 1.55$, $p>.05$] showed no significant differences (Table 26). In addition, difference of progression time (TMT B- TMT A) wasn't significantly different between the groups [$F(3,143) = 0.84$, $MS_{error} = 6108.39$, $p>.05$].

As it was displayed in Table 26, there was a significant group difference on Bender-Gestalt Test scores [$F(3,143) = 6.03$, $MS_{error} = 6.92$, $p<.001$]. Post hoc pairwise comparison indicated that ADHD-I and Control group performed

significantly better than ADHD-C ($p<.05$, and $p<.05$, respectively), and ADHD-Comorbid ($p<.01$, and $p<.01$, respectively) groups.

Table 26. Mean values of Trail Making Test and Bender-Gestalt Test

	ADHD-I (n=37)	**ADHD-C (n=37)**	**ADHD-Comor. (n=37)**	**Control (n=36)**	**F Value**
	M (SD)	M (SD)	M (SD)	M (SD)	
Trail Making Tests (TMT)					
Trail Making A Time	93.05 (43.71)	117.35 (66.85)	106.68 (49.68)	113.33 (65.64)	1.28
Trail Making A Errors	0.11 (0.31)	0.11 (0.31)	0.16 (0.44)	0.08 (0.28)	0.34
Trail Making B Time	186.19 (74.96)	232.86 (113.60)	219.30 (112.82)	222.08 (108.40)	1.32
	(n=37)	**(n=35)**	**(n=36)**	**(n=36)**	
Trail Making B Errors	0.95 (1.13)	1.09 (1.42)	1.39 (1.44)	0.81 (0.92)	1.45
	(n=37)	**(n=37)**	**(n=37)**	**(n=36)**	
TMT Difference TMT B – TMT A	93.14 (50.31)	121.53 (84.06)	112.62 (92.18)	108.75 (79.83)	0.84
Bender-Gestalt Test					
Total Errors	3.38a (2.59)	5.08b (2.98)	5.38b (2.73)	3.42a (2.13)	**6.03*** **

***p<.000

3.5.8. Cancellation Task (CT)

Six subjects (one from ADHD-I, two from ADHD-C, one from ADHD-Comorbid, and two from Control group) were determined as outliers, and subjects from AHDH groups had excessively low scores, concordant with the assumptions of the study, while subjects from the Control group had higher scores. One subject from the ADHD-C group had exeessive scores for all CT variables, excluded as an outlier for the statistical analysis, and one subject from Control group excluded from analysis for duration of organized figures. Other outliers did not have any effect on significance level of mean differences between the four groups. Therefore, they remained in the statistical analysis.

One-way between subjects ANOVA was used in the aim of comparing the four study groups. Significant group differences were obtained for the duration of

organized figures [F (3,141) = 2.68, MS_{error} = 3475.76, p<.05]; and Duncan post-hoc comparison revealed that subjects in Control group had longer time to complete the task than the subjects in the ADHD-C group (p<.05). Outcome of organized figures correct responses was significantly different between the four groups [F (3,142) = 2.67, MS_{error} = 24.22, p<.05], and Duncan's post-hoc comparison yielded that subjects in the ADHD-C group had significantly less correct responses than subjects in ADHD-I group (p<.05) and Control group (p<.05). Organized figures omission errors scores were significantly different between the four groups [F (3,142) = 2.64, MS_{error} = 24.15, p<.05]. Duncan's post-hoc group comparison revealed that subjects in the ADHD-C group had significantly more omission errors than the subjects in ADHD-I group (p<.05) and Control group (p<.05). ANOVA results yielded a significant difference between four groups in terms of the random figures correct responses [F (3,142) = 2.98, MS_{error} = 17.69, p<.05], and random figures omission errors [F (3,142) = 2.98, MS_{error} = 17.69, p<.05] (Table 27). Additionally, the subjects in ADHD-Comorbid group had significantly less random figures correct responses than subjects in Control group (p<.05). Concerning random figures omission errors, subjects in ADHD-I group had less omission errors than the subjects in ADHD-C (p<.05), and ADHD-Comorbid (p<.05) group.

Table 27. Mean values of Cancellation Tasks

	ADHD-I	ADHD-C	ADHD-Comor.	Control	F Value
	M (SD)	M (SD)	M (SD)	M (SD)	
Cancellation Task (CT)	**(n=37)**	**(n=36)**	**(n=37)**	**(n=36)**	
Organized Letters					
Duration (s)	181.70(60.77)	201.72 (69.45)	225.32 (88.70)	204.22(83.62)	2.02
Correct Responses	56.84 (3.27)	55.97 (4.06)	56.14 (4.54)	57.83 (3.15)	1.80
Omission Errors	3.16 (3.27)	4.03 (4.06)	3.86 (4.54)	2.17 (3.15)	1.86
Commission Errors			0.27 (0.16)		0.99
Organized Figures	**(n=37)**	**(n=36)**	**(n=36)**	**(n=35)**	
Duration (s)	175.54ab(58.00)	164.89a (40.14)	185.92ab (62.36)	197.40b(76.67)	**2.68***
	(n=37)	**(n=36)**	**(n=37)**	**(n=36)**	
Correct Responses	57.38b (3.46)	54.72a (6.75)	55.54ab (5.10)	57.36b (3.69)	**2.67***
Omission Errors	2.62a (3.46)	5.28b (6.75)	4.41ab (5.07)	2.64a (3.69)	**2.64***
Commission Errors	0.11 (0.32)	0.68 (2.10)	0.30 (0.91)	0.25 (0.87)	1.45
Random Letters					
Duration (s)	212.78(66.91)	190.72 (49.11)	212.59 (76.32)	220.78(76.43)	1.29
Correct Responses	57.41 (4.54)	54.89 (5.98)	56.30 (3.74)	56.56 (4.42)	1.78
Omission Errors	2.59 (4.50)	5.11 (5.98)	3.65 (3.69)	3.47 (4.44)	1.78
Commission Errors		0.03 (0.17)	0.03 (0.17)		0.67
Random Figures					
Duration (s)	158.78 (59.75)	150.58 (39.80)	156.49 (44.12)	174.08(65.06)	1.28
Correct Responses	57.70b (2.58)	55.78ab (5.90)	55.22a (4.14)	57.33b (3.52)	**2.98***
Omission Errors	2.30a (2.58)	4.22ab (5.84)	4.78b (4.14)	2.67a (3.52)	**2.98***
Commission Errors	0.08 (0.36)	0.67 (2.20)	0.16 (0.73)	0.19 (0.40)	1.81

*p<.05

As it was mentioned in the method section, for each subject the strategy of cancellation (planned/ mixed) was recorded when she/he started to circling target letters or figures. Planned cancellation strategy means circling the target in a systematic way; either from left to right (seldom: from right to left) or up and down or vice versa. Mixed cancellation strategy indicates that subjects were circling the targets irregularly / randomly.

Chi-square analysis was used to assess group differences in the strategy of cancellation. Cancellation strategies of left to right and up and down were recorded separately. But only 4 out of 147 subjects used up and down cancellation strategy and the two planned cancellation strategy were summed up in the aim to enable the Chi-square analysis assumption of having at least 5 subjects in each cell.

Outcome of Chi-square results of cancellation strategy was presented in Table 28. Cancellation strategy of organized letters [Chi-square (3, N=147) = 10.03, p<.05] and organized figures [Chi-square (3, N=147) = 21.54, p<.000] were significantly different between the groups. Ad-hoc comparison Chi-square analysis was carried out to compare groups in their strategy of cancellation; comparison of the organized letters indicated that ADHD-Comorbid group had higher level of mixed cancellation strategy than ADHD-I group [Chi-Square (1, N=30) = 4.80, p<.05].

Other groups did not significantly differ in terms of the cancellation strategy of organized letters. Concerning cancellation style of organized figures in comparison of four groups revealed significant differences, and subjects in ADHD-I group were highly preferring planned cancellation strategy than subjects in ADHD-C group [Chi-square (1, N=35) = 6.43, p<.01], in ADHD-Comorbid group [Chi-square (1, N=35) = 6.43, p<.01], and in Control group [Chi-square (1, N=33) = 8.76, p<. 01]. There was not any significant group difference in cancellation strategy of random letters and random figures.

Table 28. Cancellation style of target letters and figures

	ADHD-I (n=37)	ADHD-C (n=37)	ADHD-Comor. (n=37)	Control (n=36)	Chi-Square
Cancellation Task	**(n) %**	**(n) %**	**(n) %**	**(n) %**	
Organized Letters					**10.03***
Regular style	(28) 75.7	(20) 54.1	(16) 43.2	(25) 69.4	
Irregular style	(9) 24.3	(17) 45.9	(21) 56.8	(11) 30.6	
Organized Figures					**21.54*****
Regular style	(25) 67.6	(10) 27.0	(10) 27.0	(8) 22.2	
Irregular style	(12) 32.4	(27) 73.0	(27) 73.0	(28) 77.8	
Random Letters					2.94
Regular style	(7) 18.9	(5) 13.5	(5) 13.5	(2) 5.6	
Irregular style	(30) 81.1	(32) 86.5	(32) 86.5	(34) 94.9	
Random Figures					4.85
Regular style	(5) 13.5	(4) 10.8	(4) 10.8		
Irregular style	(32) 86.5	(33) 89.2	(33) 89.2	(36) 100	

***p<.000, *p<.05

3.6. Discriminant analysis of Conner's Parental and Teacher Rating Scales, CBCL and WISC-R

Discriminant analysis was carried out for assessing discriminating level of Conner's Parental and Teacher Rating of ADHD, behavioral assessment of CBCL, and subtests of intelligence of WISC-R between the four groups. Groups were served as dependent variables and Conner's parental, Teacher Rating Scores (inattentiveness and hyperactivity), symptoms scores of CBCL and subscale scores of WISC-R were served as independent/predicting variables.

Before running discriminant analysis, missing values, univariate (Z value) and multivariate outliers (Mahalanbis distance), and multicollinearity were tested as assumptions of discriminant function analyses. Correlation levels of dependent variables were assessed: Correlation level r = .70 and above was the exclusion criteria. As a univariate outlier screening, any variable that had a subject with a Z

value score above +/- 3.27 was excluded from analysis. In addition, Mahalonobis distance was used as multivariate outliers screening. Because of the excessive number of variables, evaluation of outliers and multicollinearity were reported before each discriminant analysis.

3.6.1. Discriminant Analysis of Conner's Parental and Teacher Rating Scales

Discriminant function analysis was carried out to predict the membership of four groups (ADHD-I, ADHD-C, ADHD-Comorbid and Control group) with four predictors of Conner's parental and teacher ratings scales of inattentiveness (CPR-I and CTR-I), and hyperactivity (CPR-H and CTR-H) scores. Multicollinearity was tested, and none of the variables had correlation level above .70. Outliers were tested: None of the subjects had Z value +/- 3.27 in variables of inattentiveness (CPR-I and CTR-I) and hyperactivitiy (CPR-H and CTR-H). Based on Mahalonobis distance analysis, one subject (ADHD-Comorbid) indicated excessive value in boxplot graph, and was excluded from the analysis as an outlier. In terms of the homogeneity of variance-covariance matrices, Box M was found as significant ($p<.001$), indicating that variance-covariance matrices were heterogenous. If the data did not contain any important outliers, discriminant function analysis is robust even when the homogeneity of variance-covariance assumption is not met. Therefore, the outcome of analysis was taken in concern as outliers of the data were evaluated before.

Three discriminant functions were calculated. The overall Wilk's Lambda was significant, χ^2 (12, N = 147) = 241.03, $p<.001$. After removal of the first function, the predictors are still significantly associated with groups, and χ^2 (6, N = 147) = 72.16, $p<.001$. However, the predictors did not significantly differentiate the four groups after partialling out the first and second discriminant functions, χ^2 (2, N = 147) = 4.15, $p>.05$. Squared canonical correlations indicated that the two discriminant functions accounted for, respectively, 70% and 38% of the total relationship between predictors and groups. The first discriminant function accounts for 78.1% of the between group variance in the solution while the second accounts for 20.7% of the between group variance. However, the contribution of

the third function to the total variance was 1.2%. Outcome of the functions at group centroids indicated that the first function was highly predictive to discriminate ADHD-Comorbid group and ADHD-C group than the other two groups, whereas the second function was highly predictive to separate ADHD-I group from the other groups. According to the structure (loading) matrix of correlations between predictors and discriminant functions, the best predictors of the first function to discriminate the groups were Conner's rating teacher hyperactivity (.67) and Conner's parental rating hyperactivity (.67). However, the best predictor of the second function was Conner's teacher rating inattentiveness (.81) variable.

Classification result of group membership revealed that 30 out of 37 subjects (81.1%) were correctly classified in ADHD-I. Twenty-six out of 37 subjects (70.3%) were correctly classified in ADHD-C group. Twenty-one out of 36 subjects (58.3%) were correctly classified in the ADHD-Comorbid group, and 32 out of 36 subjects (88.9%) were correctly classified in the Control group. Overall, 74.8% of subjects were correctly classified. The classification results of predicted group memberships are presented in Table 29.

Table 29. Classification results of Conner's Parental – Teacher Rating Scales

	Predicted Group Membership			
	ADHD-I (n=37)	**ADHD-C (n=37)**	**ADHD-Comor. (n=36)**	**Control (n=36)**
Group	(n) %	(n) %	(n) %	(n) %
ADHD-I	**(30) 81.1**	(3) 8.1	(1) 2.7	(3) 8.1
ADHD-C	(1) 2.7	**(26) 70.3**	(8) 21.6	(2) 5.4
ADHD-Comorbid	(5) 13.9	(10) 27.8	**(21) 58.3**	--- ----
Control Group	(2) 5.6	(2) 5.6	--- ---	**(32) 88.9**

74.8% of original grouped cases correctly classified.

3.6.2. Discriminant Analyses of CBCL

Predicting levels of CBCL problem behavior and symptom subscales were analyzed in terms of discriminating the four groups. Outliers and multicollinearity were checked. Five subjects (two from ADHD-I group, one from ADHD-C group, one from ADHD-Comorbid group, and one from Control group) were determined as outliers and were so excluded. Correlation coefficient indicated that total problem score had higher correlation (r equal and above .70) with anxiety/depression, aggressiveness, and attention problems. Internalizing problem score was highly correlated with symptom scores of withdrawn, and anxious/depressed, whereas externalizing problem score was highly correlated with delinquent behavior, aggressive behavior and attention problems. Therefore, total problem, internalizing and externalizing scores were excluded from discriminant analysis of CBCL. As similar to the discriminant analysis for the Conner's Scales, Box M test was found as significant ($p < .001$), indicating heterogenous variance-covariance matrices. Since the data did not contain any excessive outliers, the dicriminant anaysis was calculated.

Three discriminant functions were calculated. The overall Wilk's Lambda was significant, χ^2 (24, N = 142) = 112.78, $p<.001$. After removal of the first function, the predictors are still siginificantly associated with groups, and χ^2 (14, N = 142) = 38.67, $p<.001$. However, the predictors did not significantly differentiate the four groups after partialling out the first and second discriminant functions, χ^2 (6, N = 142) = 11.49, $p>.05$. Squared canonical correlations indicated that the two discriminant functions accounted for, respectively, 42% and 18% of the total relationship between predictors and groups. The first discriminant function accounts for 70.1% of the between group variance in the solution while the second accounts for 21.4% of the between group variance. However, the contribution of the third function to the total variance was 8.5%.

Outcome of functions at group centroids indicated that the first function was highly predictive to discriminate Control group from ADHD-Comorbid group and ADHD-C group, whereas the second function was highly predictive to separate ADHD-Comorbid group from other groups .According to the structure (loading)

matrix of correlations between predictors and discriminant functions, the best predictors of the first function to discriminate the groups were attention problems (.85), aggressive behavior (.73), delinquent behavior (.55) and thought problems (.44). However, the best predictive of the second function was only social problems (.40) variable.

Sixteen out of 35 subjects (45.7%) were correctly classified in ADHD-I group. Sixteen out of 36 subjects (44.4%) were correctly classified in the ADHD-C. Twenty-one out of 36 subjects (58.3%) were correctly classified in the ADHD-Comorbid group, and 27 out of 35 subjects (77.1%) were correctly classified in the Control group. Overall, 56.3% subjects were correctly classified. The classification results of predicted group memberships are presented in Table 30.

Table 30. Classification results of CBCL

	Predicted Group Membership			
	ADHD-I (n=35)	**ADHD-C (n=36)**	**ADHD-Comor. (n=36)**	**Control (n=35)**
Group	(n) %	(n) %	(n) %	(n) %
ADHD-I	**(16) 45.7**	(8) 22.9	(4) 11.4	(7) 20.0
ADHD-C	(9) 25.0	**(16) 44.4**	(9) 25.0	(2) 5.6
ADHD-Comorbid	(3) 8.3	(8) 22.2	**(21) 58.3**	(4) 11.1
Control Group	(2) 5.7	(3) 8.6	(3) 8.6	**(27) 77.1**

56.3% of original grouped cases correctly classified.

3.6.3. Discriminant analysis of WISC-R

Discriminant Function Analysis was used to assess the membership of four groups with predicting variables of WISC-R scores. Multicollinearity was tested, and verbal IQ was highly correlated with information (r = .73), similarities (r = .72) and vocabulary (r = .75). Performance IQ was highly correlated with block design (r = .74) and object assembly (r = .71). Both verbal and performance IQ were excluded. Outliers were tested: One subject in ADHD-I group had Z value = 3.36

in vocabulary and was excluded. Mahalonobis distance analysis indicated four subjects (one from ADHD-C group, one from ADHD-Comorbid group and one from Control group) as outliers and they were excluded from the analysis. As similar to the discriminant analysis for the Conner's Scales, Box M test was found as significant ($p < .001$), indicating heterogenous variance-covariance matrices. Since the data did not contain any excessive outliers, the dicriminant anaysis was calculated.

Three discriminant functions were calculated. The overall Wilk's Lambda was significant, χ^2 (39, N = 143) = 55.62, $p<.05$. After removal of the first function, the predictors are not siginificantly associated with groups, and χ^2 (24, N = 143) = 38.67, $p >.05$. In addition, after partialling out the first and second fuctions predictors are not significantly associated with groups as well, and χ^2 (11, N = 143) = 2.61, $p>.05$. Squared canonical correlations indicated that the first

discriminant function accounted for 20% of the total relationship between predictors and groups. The first discriminant function accounts for 55.5% of the between group variance in the solution while the second accounts for 40.2% of the between group variance. However, the contribution of the third function to the total variance was 4.3%. Outcome of functions at group centroids indicated that the first function was highly predictive to discriminate Control group from ADHD-Comorbid group and ADHD-C group .According to the structure (loading) matrix of correlations between predictors and discriminant functions, the best predictors of the first function to discriminate the groups were mazes (.50), comprehension (.44), information (.35), digit span (.35), and block designs (.25)

Classification result of group membership showed that 18 out of 36 subjects (54.3%) were correctly classified in ADHD-I. Twelve out of 36 subjects (30.6%) were correctly classified in ADHD-C group. Fourteen out of 36 subjects (41.7%) were correctly classified in the ADHD-Comorbid group, and 19 out of 35 subjects (54.3%) were correctly classified in the Control group. Overall, 44.1% subjects were correctly classified. The classification results of predicted group memberships are presented in Table 31.

Table 31. Classification results of WISC-R

	Predicted Group Membership			
	ADHD-I (n=36)	**ADHD-C (n=36)**	**ADHD-Comor. (n=36)**	**Control (n=35)**
Group	(n) %	(n) %	(n) %	(n) %
ADHD-I	**(18) 50.3**	(6) 16.7	(5) 13.9	(7) 19.4
ADHD-C	(6) 16.7	**(12) 33.3**	(11) 30.6	(7) 19.4
ADHD-Comorbid	(6) 16.7	(9) 25.0	**(14) 38.9**	(7) 19.4
Control Group	(8) 22.9	(5) 14.3	(3) 8.6	**(19) 54.3**

44.1% of original grouped cases correctly classified

3.7. Discriminant analysis of Executive Functions

Because of excessive amount of executive function variables, only variables that have significantly high correlation with CBCL scores and Conner's rating scales score were used in discriminant analysis as predictor variables. In accordance, EF variables were consisting of Tower of London (ToL); number of correct responses, number of total moves, and initiation time, Wisconsin Card Sorting Test (WCST); number of total responses, number of total errors, number of categories completed, perseverative errors, conceptual level responses, and category perseverative, California Verbal List for Children-Revised (CVLT-R) ; total recall list A, short delay free recall, long delay free recall, long delay cued recall, total intrusion, total semantic cluster, correct recognition hits, discriminability, and false positives, Continuous performance test (CPT) commission errors, Stroop STR/5 correction, total Stroop time, Bender-Gestalt Test, Cancellation Task (CT) organized figures correct responses, and organized figures omission errors, random figures correct responses, random figures omission errors.

Multicollinearity was checked, and variables of WCST total responses, total number of error, perseverative errors, percentage of conceptual level responses, Stroop (STR) STR/5 correction, total Stroop time, CPT commission errors, CVLT

short delay free recall, long delay free recall, semantic cluster, correct recognition, total intrusion had excessive correlation (r = .70), and were excluded from discriminant analysis. In the assessment of outliers, two subjects were detected (one from ADHD-C group, and one from ADHD-Comorbid group), and were excluded. There were no missing variables.

Variables of EF discriminant analysis were as follows: ToL number of correct responses, number of total moves, CVLT-R total recall list A, false positives, correct recognition hits, total intrusions, WCST number of correct responses, number of perseverative responses, number of categories completed, Bender-Gestalt Test, CT organized figures omission errors, and random figures omission errors. These twelve EF variables served as predicting variables for discriminating the four groups.

Outcome indicated that the mean scores of 10 variables out of 12 were significantly different (had significant F value). Therefore, variables of WCST number of perseverative responses, CT organized figures omission errors, and CVLT-R false positives were excluded. As similar to the discriminant analysis for the Conner's Scales, Box M test was found as significant , indicating heterogenous variance-covariance matrices. Since the data did not contain any excessive outliers, the dicriminant anaysis was calculated.

Three discriminant functions were calculated. The overall Wilk's Lambda was significant, χ^2 (27, N = 145) = 45.07, p<.05. After removal of the first function, the predictors are not significantly associated with groups, and χ^2 (16, N = 145) = 15.10, p >.05, and after removal of first and second function, the predictors are not significantly associated with groups, and χ^2 (7, N = 145) = 4.62, p>.05. Squared canonical correlations indicated that the first discriminant function accounted for 20% of the total relationship between predictors and groups. The first discriminant function accounts for 68.2% of the between group variance in the solution while the second accounts for 22.2% of the between group variance. However, the contribution of the third function to the total variance was 9.6%.

Outcome of functions at group centroids indicated that the first function was highly predictive to discriminate Control group from ADHD-C group and ADHD-

Comorbid group. According to the structure (loading) matrix of correlations between predictors and discriminant functions, the best predictors of the first function to discriminate the groups were CVLT-C total recall List A (-.65), Bender-Gestalt Test (.65), ToL number of total moves (.64), WCST perseverative errors(.52), WCST number of correct responses (.49), and CT organized figures omission errors (-.46).

Classification result of group membership revealed that 16 out of 37 subjects (43.2%) were correctly classified in ADHD-I. Seventeen out of 36 subjects (47.2%) were correctly classified in ADHD-C group. Fifteen out of 36 subjects (41.7%) were correctly classified in the ADHD-Comorbid group, and 18 out of 36 subjects (50.0%) were correctly classified in the Control group. Overall, 45.5% subjects were correctly classified. The classification results of predicted group memberships are presented in Table 32.

Table 32. Classification results of Executive Function variables

	Predicted Group Membership			
	ADHD-I (n=37)	**ADHD-C (n=36)**	**ADHD-Comor. (n=36)**	**Control (n=36)**
Group	(n) %	(n) %	(n) %	(n) %
ADHD-I	**(16) 43.2**	(6) 16.2	(8) 21.6	(7) 18.9
ADHD-C	(7) 19.4	**(17) 47.2**	(6) 16.7	(6) 16.7
ADHD-Comorbid	(6) 16.7	(10) 27.8	**(15) 41.7**	(5) 13.9
Control Group	(8) 22.2	(3) 8.3	(15) 19.4	**(18) 50.0**

45.5% of original grouped cases correctly classified

CHAPTER 4

DISCUSSION

The purpose of this study was mainly to examine the differences and relations of intelligence, behavioral problems and executive functions (EF) such as inhibition, working memory, planning and set-shifting in children with and without ADHD, as well as the discriminative effectivity of EF measures in study groups. Four groups (ADHD-I, ADHD-C, ADHD-Comorbid and Control) were compared on intelligence, behavioral problems and EF measures. Special attention was given to the recruitment of groups to eliminate sampling biases. For the study, 147 children were characterized and cross-matched via structured interview according to DSM-IV-R criteria and multi-informant ratings (parents, teachers), as it was explained in detail in the Method section. All dependant variables examined for outliers and normality was reported in the Result section.

4.1. Demographic Characteristics

Demographic characteristics of children and parents were obtained through with a structured questionnaire which is prepared by the researcher (see Appendix 1.) Family income and parental age did not significantly differ between groups while education level of the mothers was significantly higher for the control group children. Concerning mother's educational level, the specific ADHD groups did not show any difference among themselves. Education level of father was in the ADHD-Comorbid group significantly lower than in the ADHD-I, and Control groups. Previous studies indicated the lower educational level of parents of children with ADHD, which was evaluated as a possible indicator for psychopathology (Stawicki, Nigg and Eye, 2006; Biderman and Faraone, 2005).

In this study, ADHD was less common in families of the subjects in the ADHD-I, ADHD-C and Control groups, while in ADHD-Comorbid group 20 out of 37 (54%) first-degree relatives displayed ADHD according to parental report. Previous reviews indicated that probability of ADHD existence in other family members was found 2 to 8 times more in children with ADHD than control groups (Hetchman, 2005; Pennington and Chhabildas, 2003), and it is pointing to environmental risk factors for ADHD (Anstel, et al. 2007; Biderman, 2005). In another study that was conducted by Aydın, Diler, Yurdagül, Uğuz, and Şeydaoğlu (2006) and revealed that 23 parents (33.8%) from the study group who had children with diagnosis of ADHD and 2 (6.3%) from the control group had adult Attention Deficiency Hyperactivity Disorder symptoms. The difference between the study and the control groups was statistically significant. In addition, Kaplan, Crowfar, Fisher, and Dewey (1998), in their study evidenced that families had an ADHD child having significantly more familial problems and problem in decision-making than control groups. According to authors, there might be two reason for that; the first one is unpredictable behavior patterns are characteristics of children with ADHD, secondly, parents might have characteristics of ADHD themselves. Parents with family problems and /or marital problems might have difficulty in decision making and putting boundaries to their child.

Even though, there was not a significant difference between ADHD-Comorbid and Control groups except in the fact that the former were much less welcomed as babies of planned pregnancies. Almost half of the mothers of the ADHD-Comorbid group declared that they have not wished to give birth of the index child. This fact points out to an important issue in the attachment theory. Lieberman and Zeanah, (1995) mentioned that the unsecure attachment in the anxious mother-infant relationship might cause more avoidant, resistant or disorganized / disoriented infants than secure ones. Development of secure attachment between mother and infant, mainly bases on maternal psychological status, marital quality and feeling ready to have a baby. Mothers of ADHD-Comorbid group additionally stated having significantly more stressed pregnancies than, mothers of other study groups. Both ADHD-C and ADHD-Comorbid group

children were reported to be sleeping much less than normal, compared to the ADHD-I and control group, which can be considered as a risk factor for future development of ADHD (Rutter, Taylor and Hersov, 1994).

Parents of ADHD-Comorbid children reported significantly low school achievement, problems in writing (missing letters) and rejection by peers. Shealey (1994), states that it is not unusual for children with ADHD to have academic problems, even without a diagnosis of Learning Disability; usually they have learning problems and academic deficiencies that need an intervention. Fighting with peers was significantly higher for children in ADHD-C group. According to Barkley (1997) children with ADD with hyperactivity were less liked by their peers, and had poorer relationships with them.

4.2. Behavioral Problems

In the aim of assessing behavioral problems of subjects in four study groups, parental rating Child Behavior Check List was administered. Overall outcome of parental rating was concordant with the literature. CBCL is mainly used in the aim of assessing comorbidity of behavioral problems with ADHD (Biederman, Monuteaux, Kendrick, Klein, and Faraone, 2005; Biederman, Ball, Monuteaux, Kaiser, and Faraone, 2007). In the present study, comparison of the behavioral problems between the four groups was aimed.

Firstly, relationship of CBCL scores with Conner's parental, teacher rating scale scores and intelligence scores were evaluated. Parental and teacher ratings of inattentiveness and hyperactivity in the four study groups were related with CBCL problem scores (internalizing, externalizing and total problem). Concerning the CPR-I, Internalizing, Externalizing and Total Problem score in ADHD-I group, only parental rating of externalizing and total problem scores had positive correlation with parental rating of hyperactivity scores. The outcome was concordant with the assumption, that children with hyperactivity display more externalizing problem behavior (Barkley, Du Paul, and McMurray, 1990). No significant relation was observed between Conner's Rating Scales (CPR-H) and CBCL problem behaviors (externalizing, total problem score) in ADHD-C and

ADHD-Comorbid groups. In Control group subjects, parental rating inattentiveness had correlation with both internalizing and externalizing scores, as well as total problem scores, and parental rating hyperactivity had correlation with externalizing and total problem scores. Teacher rating of hyperactivity showed positive correlation with CBCL internalizing and externalizing problem scores in the Control group. The outcome of Control group was concordant with the literature, as inattentiveness was related to internalizing problems, while hyperactivity was related to externalizing problems (Jonsdottir, Bouma, Sergeant, and Scherder, 2006; Barkley, Du Paul, and McMurray, 1990; Barkley, 1997).

Secondly, CBCL problem behavior scores and CBCL symptoms scores were compared in the four study groups yielded the following findings: Control group had significantly lower scores than the ADHD-I group, ADHD-C group, and ADHD-Comorbid group in general, only with one exceptional outcome, that ADHD-I group and Control group did not significantly differ in delinquent behavior score. It means, both ADHD-I group and Control group had significantly lower scores than ADHD-C group and ADHD-Comorbid group in delinquent behavior.

ADHD-I group had higher score in internalizing problems than other three groups. As it was mentioned above, this outcome was concordant with the literature. In addition, concerning outcome of CBCL subtest scores for ADHD-I group; somatic complaints and withdrawn were slightly higher than in the other ADHD groups. ADHD-C group and ADHD-Comorbid group had higher scores in CBCL total problem and externalizing problems. This finding was also concordant with the literature (Barkley, 1997; Gadow et al. 2004; Jonsdottir, Bouma, Sergeant, and Scherder, 2006). In general, ADHD-C and ADHD-Comorbid groups had similar scores in syndrome subtest of CBCL. The observed difference between the two was in the scores of social problems, and of aggressive behavior, which were significantly higher for ADHD-Comorbid group. Attention problems, thought problems and anxiety / depression problems were quite similar in the three ADHD groups. ADHD-Comorbid group displayed more impairment in social problems, showed heavier aggressive behavior and had slightly more delinquent behavior.

There is an assumption in literature that higher order cognitive deficits associated with poor self-regulation and impaired strategic planning causes adjustment difficulties in children with ADHD, with or without comorbidity of ODD or CD (Cherly, Clark, Prior and Kinsella, 2002). This assumption is related to the EF abilities of ADHD children. In the present study, ADHD-Comorbid group was more impaired in externalizing behavior pattern, and it would be an accurate outcome when symptoms of ODD and CD were concerned. In the present study as it was mentioned above, CBCL was used in the aim of screening difference of behavioral problems in four study groups. On the other hand, some recent studies indicated the discriminative ability of CBCL in children with ADHD for diagnosing ODD, and found that the aggression scale was the most effective CBCL scale for identifying children with ODD and CD, while delinquent behavior scale contains the best predictors of CD (Biederman, Ball, Monuteaux, Kaiser, and Faraone, 2007; Biderman, Monuteaux, Kendrick, Klein, and Faraone, 2005). This outcome also concordant with the previous study, as ADHD-Comorbid (ADHD-C+ODD/CD) group had significantly higher scores in CBCL aggressive behavior scale.

Briefly, parental assessment of behavioral problems in the four study groups indicated that ADHD-I group displayed more internalizing (somatic, withdrawn) problems than ADHD-C and ADHD-Comorbid groups. ADHD-C and ADHD-Combined group had more externalizing problems than ADHD-I and Control group. In addition, ADHD-Comorbid group displayed more impairment in social problems and aggressive behavior. All three ADHD groups showed no difference concerning the symptoms of attention problem, thought problem and anxiety / depression.

4.3. Intelligence

Outcome of intelligence scores was evaluated from different perspectives. Initially, differences between WISC-R subtests, verbal, performance, and full scale raw and standardized scores were overviewed. Later relationships between WISC-R and Conner's parental-teacher ratings, EF scores between groups were evaluated.

In this study, as it was mentioned before, FSIQ level 90-above was one of the recruitment criteria for the study; additionally all groups were matched in accordance to their FSIQ level. Therefore, it was not expected to get significant difference between the four groups in their overall IQ level. Despite of that, groups differed significantly in their VIQ score as well as in verbal subtests of comprehension, and performance subtest of mazes in standardized scores of WISC-R. Concerning the differences between the groups; children in Control group had higher scores in all of them, as expected. On the other hand, in this study raw scores of WISC-R subtests and composed intelligences scores (VIQ, PIQ, FSIQ) were assessed in the aim of getting more accurate evaluations between the groups in the terms of their WISC-R scores. Significant difference was observed in verbal subtests of information, arithmetic, comprehension, and performance subtests of picture completion, and mazes. Comparing raw and standardized scores of WISC-R, both outcomes were concordant with the previous researches (Erdogan-Bakar, Soysal, Kiriş, Şahin and Karakaş, 2005; Mahone et al. 2003). Comparison of Raw scored WISC-R subtests between groups indicated better performance in children with ADHD-I type with subtests of arithmetic, comprehension and picture arrangement. Because there was not any study about raw scores of WISC-R subtest to compare, it was difficult to make an evaluation. However, in this study children with ADHD-I type had similar performance with normal Control group. As it will be seen below, the combined and predominantly inattentive types of ADHD are considered distinct and unrelated disorders (Milich, Balentine, and Lynam, 2001). On the other hand, Evinç and Gençöz (2007) concluded that WISC-R profiles would not accurately diagnose ADHD on its own.

Children with ADHD were less successful on ACID and Freedom from Distractibility factors. The relative performance decrement on these subtests may reflect EF limitations (Barkley, 1997; Shuck and Crinella, 2005). In the present study, significant group difference was obtained in Freedom from Distractibility and ACID scores. Consequently, the Control group had significantly better performance than ADHD-Comorbid group, and ADHD-I group and ADHD-C group did not significantly differ from the Control or ADHD-Comorbid groups in

ACID and Freedom from Distractibility scores. Differences were concordant with the assumption of previous research outcomes, that children with ADHD would get lower scores in ACID and Freedom from distractibility factor (Ek, 2007; Mayes, Calhoun, and Crowell, 1998; Watkinson, Kush, and Glutting ,1997).

Relationships between EF, ADHD and IQ are important concerns in the literature with a question that whether Executive Functions are really discernable from cognitive ability, specifically the IQ. On the other hand, most of the studies that assessed the relationships between ADHD and EF or predicting power of EF tests over ADHD did not match the study groups in intelligence level, and assumed that ADHD would lessen the FSIQ score at some point. In some studies, the Full Scale IQ was used as covariate, and in most of them, the significant difference between ADHD and Control groups in EF tests / tasks were diminished after covariating FSIQ (Arffa, Lovell, Podell, and Goldberg, 1998; Jonsdottir, Bouma, Sergeant, and Scherder, 2006; Harier, and Deonellas, 2005). However, the EF assessment of subjects in the present study indicated that level of IQ was an important factor. Subjects who have higher Full Scale IQ (IQ above 110), performed better than subjects with average (IQ between 90 and 109), independent from their matched groups. It was very clear that subjects in Control group with average FSIQ level (FSIQ = 90) displayed similar performance in EF tasks with subjects in ADHD groups. Concerning previous studies, cut-off point for FSIQ generally was 80, with an argument that symptoms of ADHD would effect the performance of intelligence tests and reduce the FSIQ for nine points. Mahone et al. (2007) revealed that superior or above average IQ improved the performance of children in both ADHD and Control groups, and IQ scores accounted for consistently greater proportion of variance in EF measures (average of 10%) than the diagnosis of ADHD (average of 0.4%).

Relationships between intelligence (IQ) with parents and teachers ratings of inattentiveness and hyperactivity, indicated that rating of ADHD-I group's teachers' Conner's inattentive scores showed significant negative correlation with VIQ, PIQ, and FSIQ. It means, when inattentiveness increased, the intelligence score / performance decreased. Similar relationship was observed in subjects of the

Control group, with the exception, that CTR-I had positive correlation with VIQ and FSIQ, while displaying negative correlation with PIQ. The reason might be that some research indicated strong relationship between inattentiveness and verbal fluency. In addition, the authors concluded that children, who were weak in verbal expression, would have poor performance on verbal fluency tasks, and tend to have more internalizing characteristics (Brocki, and Bohlin, 2006). The teachers would easily observe the verbal academic performance, and inattentiveness of the children in classroom setting. Another reason for positive correlation between VIQ, FSIQ and CTR-I would be, that in normal subjects with higher IQ level, teachers might have higher expectancy from the subjects, and any unexpected performance of learning would be connected with inattentiveness.

4.4. Relationships between Conner's Parental and Teacher Rating Scales, Intelligence, Behavioral Problems and Executive Functions

Possible correlations between intelligence scores and EF scores were looked for: In the ADHD-I group WCST perseverative and total number errors were negatively correlated with P IQ and FSIQ scores. Difficulty in set-shifting was negatively related to PIQ and FSIQ, while difficulty in planning (ToL number of correct responses and ToL total initiation time) had negative correlation with teacher's rating of hyperactivity. This outcome was concordant with findings of Hagemann, Hay and Levy (2002), as they concluded that subjects in ADHD-I group had a deficit in tasks that required mental but not behavioral control, in particular set-shifting and, to a lesser degree, planning. Teacher's rating of inattentiveness had positive correlation with WCST total number of errors, WCST perseverative responses and perseverative errors, whereas negative correlation existed between WCST conceptual level responses, and WCST number of categories completed. This outcome indicates that teachers in ADHD-I group were quite accurate to rate their students' inattentiveness, as well as hyperactivity. Especially, ToL initiation time gives very clear evidence about subject's planning of sequential movements, and literature evidenced that children with hyperactivity and impulsivity could not plan sequential movements, and to have a shorter

initiation time could be seen as an indicator of impulsive style (Culbertson, and Zillmer, 2000; Pasini, Paloscia, Alessandrelli, Porfitrio, and Curatolo, 2007; Lezak, Howieson, and Loring, 2004). Externalizing had positive correlation with ToL number of correct responses, while internalizing had positive correlation with CT organized letters correct responses. This outcome was quite concordant with ADHD-I group subjects' test performance. Subjects with internalizing characteristics, in other words, introvert manner were more patient and planned while circling out target letters, on the contrary same manner was not very effective for ToL correct responses, because of exceeding time limits.

Teacher rating of inattentiveness had positive correlation with CPT omission errors in ADHD-C group. In other words, exceeding level of inattentiveness causes exceeding amount of omission errors. In addition, externalizing characteristics of ADHD-C group had significant effect on category perseverative errors, and increasing FSIQ level was related to increasing level of Go-No-Go commission errors. Both of these outcomes indicated disinhibition of thought and behavior, that was concordant with previous research outcomes (Barkley, 1997; Hagemann, Hay and Levy, 2002; Paloscia, Alessandrelli, Porfitrio, and Curatolo, 2007; Oosterlaan and Sergeant, 1998a). On the other hand, teacher's rating hyperactivity scores had negative correlation with WCST perseverative responses and perseverative errors. It indicated that subjects with ADHD-C group would not have problems with set-shifting or cognitive flexibility (Geurts, Verte, Oosterlaan, Roeyers, and Sergeant, 2005) but problems with behavioral inhibition.

High parental ratings of inattentiveness were negatively associated with CVLT-C total semantic cluster, CVLT-C correct recognition hits, CVLT-C discriminability, and positively associated with CPT omission errors in ADHD-Comorbid group. It indicated, that the more inattentive the subject the more verbal learning / verbal encoding problems would occur. High parental ratings of hyperactivity indicated better performance in CT duration of random figures, CVLT-C correct recognition hits, CVLT-C total intrusion and CVLT-C total recall. Parental rating of inattentiveness and hyperactivity might be founded in an interpretation problem of child's behavior. Making it clear, the performance of the

children in verbal learning and attention tasks would be underestimated or incorrectly judged by parents. Thus, hyperactivity of the child was seen as a relatively positive behavior and perceived as an improving factor in the verbal learning and attention. This might be a basic problem of ODD, as children of ODD parents / families have serious problem with boundary settings and display higher tolerance level towards their children. Teacher rating inattentiveness had significant correlation with CT random figures errors representing visual selectivity / visual scan. Significant correlation was observed between higher VIQ and lower Stroop interference effect. In other words, higher VIQ would enable subject to inhibit usual response and exhibit more difficult reaction (e.g. instead of name reading, saying color of ink). PIQ and FSIQ showed positive correlation with CT organized letters correct responses, whereas negative correlation with Go-No-Go omission errors. Higher PIQ and FSIQ had a positive effect on audio-visual attention of subjects in ADHD-Comorbid group. Both externalizing and total problem scores had negative correlation with WCST failure to maintain set, while showing positive correlation with CT random letters errors. It means, that subjects in ADHD-Comorbid group with higher externalizing and total problem score would not have higher failure to maintain set errors in WCST; they would have exceeding scores in CT random letters errors.

In Control group, parental rating of inattentiveness had negative correlation with CVLT-C; total recall, short delay free recall, long delay free recall, total perseveration errors, total semantic clustering, and discriminability, whereas positive correlation was yielded with CVLT-C false positive errors. Consequently, parental rating of hyperactivity scores had negative correlation with CVLT-C Total perseveration, and had positive correlation with Stroop naming ink color time (STR/5 time), ToL total time violation.

Correlation results of Control group indicated that parental rating inattentiveness was related with weaknesses in verbal learning and verbal memory. Parental rating of hyperactivity was negatively related with set-shifting and positively related with interference. In contrary, scoring of parents, in Control group (hyperactivity) were not reflecting perception problems of child behavior as

it was the case for the ADHD-Comorbid group. In other words, in Control group, excessive parental rating hyperactivity score was related to higher impairment in attention (CVLT-C total perseveration), interference (STR/5) and planning ability (ToL total time violation). However, in ADHD-Comorbid group, excessive parental rated hyperactivity score was related to improvement in verbal learning ability (CVLT-C total list A), accuracy rate of subjects verbal screening (CVLT- C correct recognition hits), decreasing on the weaknesses in verbal skills, and verbal learning disability (CVLT-C total intrusion).

Teacher rating inattentiveness had negative correlation with CVLT-C total recall, CVLT-C short free recall, and Bender-Gestalt test error score in Control group. Teacher rating hyperactivity had positive correlation with CT organized figures errors. It means, teacher rating of inattentiveness indicated weakness in verbal learning and short term verbal memory while having no connection to visually copying shapes. Teacher rating hyperactivity was related with exceeding disinhibition.

In Control Group, PIQ had positive correlation with CVLT-C short cued recall, negative correlation with STR/5 errors, and CT random figures errors. FSIQ had positive correlation with CVLT-C short cued recall. Concluding that high PSIQ and FSIQ were related with improved short term verbal memory, and decreased disinhibiton. Internalizing behavioral problem score had negative correlation with total semantic cluster, while externalizing had positive correlation with category perseverative errors in category verbal fluency test, and negative correlation with CT random figures errors. In addition, both internalizing and externalizing scores were negatively related with CVLT-C total perseveration and CVLT-C short free recall. Total behavioral problem scores had negative correlation with CVLT-c short free recall, CVLT-C long free recall, CVLT-C total perseveration, CVLT-C total semantic cluster, and positive correlation with ToL total time of violation. Concerning behavioral problems, internalizing problems were related with weaknesses in verbal learning and verbal memory, while externalizing was related with impairment in verbal learning, and disinhibition. Total problem scores had relation to weaknesses in verbal learning and planning.

4.5. Executive Function Tests / Tasks

One of the aims of this study was to assess differentiation between the four study groups in terms of their Executive Functioning performance. Under this section significant EF tests / tasks scores were compared between the four groups.

In terms of ToL test, number of correct responses, number of total moves, and total initiation time showed significant mean differences between the four groups. Significant difference was observed between the ADHD-Comorbid and Control group in number of correct responses and total initiation time. The rest of the groupings (e.g. ADHD-C versus ADHD-C, ADHD-I versus Control or ADHD-C versus Control) showed no significances. In the ToL number of correct responses, performance of ADHD-C and ADHD-Comorbid groups was significantly lower than Control group, but not ADHD-I group. In other words, planning ability differed significantly between the four study groups, and the outcome was concordant with the Barkley's ADHD theory of EF difference between the subtypes of ADHD. He proposed that ADHD-I type group have impairment in selective attention, ADHD-C group involves problems with behavioral inhibition, and self control which is associated with poor executive control and planning (Barkley, 1997; Hageman, Hay and Levy, 2002; Nagileri, and Goldstein, 2006). Some of the previous literature did not support this theory and no significant difference was observed between the subtypes of ADHD (Geurts, Verte, Oosterlaan, Roeyers, and Sergeant, 2005; Pasini, Paloscia, Alessandrelli, Porfirio, and Cuartolo, 2007; Willcutt, Doyle, Nigg, Faraone, and Pennington, 2005). Similar outcome was yielded in the present study; only Control group and ADHD-C and ADHD-Comorbid groups were significantly different in their planning ability. In addition, Sergeant, Geurts and Oosterland (2002) in their study of meta-analytic review mention only one study revealing that children with ODD had more impaired planning ability than control group.

In the aim of assessing cognitive flexibility and set-shifting WCST was used. WCST scores of number of total responses, total number errors, number of categories completed, perseverative errors and percent of conceptual level of responses were significantly different between the groups. Control group had better

performance than other groups in overall, but concerning statistically significant outcomes, ADHD-I group and Control group did not differ at all. Control group had less total errors than ADHD-C and ADHD-Comorbid groups, while having higher conceptual level responses than the latter ones. In addition, Control group had less perseverative errors than ADHD-C group. These differences between the groups indicated that the ability to develop problem solving strategy in a new environment, in other words, cognitive flexibility, was better in Control group than the others. Concordant with Barkley's (1997) assumptions about hindsight (the ability to adjust subsequent responses based on immediately past incorrect ones) and forethought (planning ability), children with ADHD had difficulty to use hindsight and forethought in a novel situation. ADHD-C group had higher level of inability to suppress an ongoing activity despite of being told that it is no longer appropriate. Even though, ADHD-Comorbid and ADHD-I groups did not significantly differ from Controls, their amount of total perseverative errors were still higher. Control group and ADHD-Comorbid group had significant differences in the score of number of categories completed. This indicated that Control group subjects' concept formation; with requirement of the subject to make use of positive and negative feedback to formulate problem solving strategies, was significantly better than ADHD-C group, while slightly better than ADHD-I and ADHD-C groups.

Outcome of present research was concordant with the previous ones, concluding that WCST can differentiate between ADHD and Control groups (Grodzinsky, and Barkley, 1999; Sergeant, Geurts, and Oosterlaan 2002; Tripp, Ryan, and Peace, 2002). On the other hand, concordant with the present study, no significant difference was observed between ADHD-I and ADHD-C groups in perseverative errors of WCST (Denckla, 2005; Willcutt, Doyle, Nigg, Faraone, and Pennington 2005). Same studies evidenced no significantly different outcome neither between two subtypes of ADHD-I and ADHD-C nor between them and the control group (Geurts, Verte, Oosterlaan, Roeyers and Sergeant, 2004).

Verbal fluency (K-A-S) and category fluency (animal-fruit) measures were used for organized memory search, sustained production and semantic fluency.

Study groups were significantly different in category perseverative score. Subjects in ADHD-C group had significantly more category perseverative errors than subjects in ADHD-I and control group. In their meta-analysis study, Sergeant, Geurts, and Oosterlaan (2002) reported that three out of six studies found significant difference between ADHD and control group in terms of verbal fluency task, and 2 out of 9 studies of category fluency task found significant difference between ADHD and control groups. Grodzinsky and Barkley (1999) found that the F-A-S (K-A-S) task have good positive predictive power, correctly identifying 90% of children with ADHD. On the other hand, 68% of children with ADHD scored in the normal range with an indication of low sensitivity. In another comprehensive review, only half of the reviewed studies found significant differences between groups of ADHD versus control, suggesting questionable clinical utility of F-A-S (Rapport, Chung, Shore, Denny, and Isaacs, 2000). Cohen, Morgan, Vaughn, Riccio and Hall (1999) yielded that performance of ADHD group was not found to be impaired in verbal fluency task, and they concluded that significant difference of verbal fluency in subjects with ADHD might be due to comorbidity of developmental dyslexia or learning disability with ADHD. Another point for non-significant difference in the present study would be due to subjects' limited vocabulary capacity as their families were representing middle and lower class of socio-economical status.

California Verbal List Test for Children (CVLT-C) measures strategies and processes involved in learning and recalling verbal material, as well as verbal learning memory strengths and weaknesses. Significant differences were observed in scores of total recall list A, short delay free recall, long delay free recall, long delay cued recall, total intrusion, total semantic clustering, recognition hits, discriminability, and false positives.

Total recall list A, in other words, verbal learning ability as well as auditory attention was significantly better for ADHD-I and Control groups than ADHD-C and ADHD-Comorbid groups. Short term verbal memory was significantly better for control group than for the ADHD-C and ADHD-Comorbid groups. Concerning long-term verbal memory; control group was significantly better than ADHD-

Comorbid group, same as in long delay cued recall. CVLT-C intrusion score might reflect weaknesses in verbal skills or verbal learning disability (Delis, Kramer, Kaplan, and Ober, 1994). Subjects in ADHD-Comorbid group had more verbal learning disability than Control group. As total semantic clustering relates with actively imposing on organization of words according to shared semantic features, significant difference in semantic clustering reflects that subjects in ADHD-C and ADHD-Comorbid group would not use semantic categorization in verbal learning, while subjects in Control group and ADHD-I group would do. Recognition hits refer to the ability to distinguish target words from the distracted words. Significant difference in recognition hits indicated that subjects in Control group had better distinguishing target words than subjects in ADHD-C group. Concerning discriminability; accuracy rate of subjects' verbal screening was significantly higher in Control group than ADHD-C and ADHD-Comorbid group.

Overall, outcome of CVLT-C indicates that subjects in ADHD-C and ADHD-Comorbid group had more problems with verbal learning ability, auditory attention, long term memory and short term memory.

There is not any study that used CVLT-C in children with ADHD. Therefore the outcome of this research could not be compared with some other findings. On the other hand, according to Denckla (2005) cued recall intrusion and free recall intrusion errors on CVLT-C could point out to the executive dysfunction of inhibition, so CVLT-C might give valuable information for comorbide learning disorders, especially for children in ADHD-I group.

Continuous Performance Test (CPT) and Go-No-Go Task were evaluated together. Both tests aimed to assess inhibitory control, and attention. In the present study, only CPT omission errors were found significantly different between groups, which revealed that children in ADHD-Comorbid group were significantly worse in attention domain than Control and ADHD-I groups. Ricco, Homack, Jarratt and Wolfe (2006) concluded that CPT omission and commission scores were accurately discriminating ADHD from Control groups. In this respect, omission errors are generally reflecting attentional lapses, while commission errors are reflecting disinhibition.

In the present study, CPT task was pressing enter-button, when the targeted letters appeared in the plain computer screen. Therefore, it was not attractive to the subjects; pressed the enter button carelessly, wondering the ending of the task.

Lack of non-significance in Go-No-Go task would be due to two reasons. Auditory attention of ADHD subjects might not be impaired. Also the inattractiveness of the test could have played a role: Only bipping sounds were given in a back computer screen, and many of the children asked the ending time of the task.

In the aim of assessing selective attention and response inhibition, Stroop Color-Word TBAG version was used. Time of naming plain letters (STR/1), time of naming colored letters (STR/2), time of naming colored shapes (STR/3), and time of naming color of colors (STR/5) were significantly different between the groups. Time of the naming color of words (STR/4), and Stroop interference effect (STR/5 – STR/4) were not significantly different between the groups. Significantly different Stroop interference effect / control was observed in the present study, but the significance level was rather low. However, subjects in ADHD-I group and Control group had better performance than subjects in ADHD-Comorbid group. This outcome was concordant with Barkley's theory of ADHD, as he assumed that children with ADHD have difficulties to suppress the familiar response for eliciting more unusual / difficult ones (Barkley, 1997). Previous studies reported different outcomes; some of them concluded that Stroop interference effect / control would differentiate ADHD from Control group (Sergeant, Geurts, and Oosterlaan 2002; Grodzinsky and Barkley, 1999), while others reported no significant differences (Riccio, Homack, Jarratt, and Wolfe, 2006; van Mourik, Oosterlaan, and Segeant, 2005; Willcutt, Doyle, Nigg, Faraone, and Pennington, 2005).

On the other hand, total Stroop time was significantly different between the groups and subjects in Control group used less time than, subjects in ADHD-C group for completing the task. In addition, depending on clinical observation all items of Stroop test would be indicating to evaluate children with reading and learning problems. As Rucklidge and Tannock (2001) indicate, non-significant Stroop color naming contrast between groups may be due to preliminary

elimination of reading disorder (RD) in the ADHD study groups. ADHD+RD might be a specific subtype, and only when both disabilities are present in an individual, there is severe impairment in speed of naming colors.

Colored Trail Making Test was used to assess attention, concentration, resistance to distraction, and set-shifting. Outcomes of Colored Trail Making-A and Colored Trail Making-B were not significantly different between the groups. The finding is concordant with the literature (Grodzinsky, and Barkley, 1999; Tripp, Ryan, and Peace, 2002; Willcutt, Doyle, Nigg, Faraone, and Pennington, 2005;).

Bender-Gestalt Test error scores were significantly different between the groups, and performances of Control group and ADHD-I group were significantly better than that of the ADHD-C and ADHD-Comorbid groups. In other words, subjects in ADHD-C and ADHD-Comorbid groups had more errors in their copying task of shapes.

Cancellation Tasks were administered in the aim of assessing sustained attention, visual searching and scanning as well as motivational components. Organized figures omission and commission errors scores, organized figures duration times, and random figures omission and commission errors were significantly different between the groups. Control group and ADHD-I group had significantly less omission errors than ADHD-C group. Significantly different outcomes indicated that, even though duration of cancellation time decreased after completing each task consequently in four study groups, omission errors were increased in ADHD- C and ADHD-Comorbid group. It means, that subjects in ADHD-C and ADHD-Comorbid group had difficulty in their sustained attention for longer periods of time. This was the one of the assumptions of the Barkley's theory of EF in ADHD (Barkley, 1997), and was also concordant with the outcome of the study of Kılıç, Şener, Koçkar, and Karakaş (2007).

Subjects' strategy of cancellation style was recorded during the administration of tests. Two different strategy styles; planned and mixed were recorded. As it was expected, depending on clinical experience, cancellation strategy of organized letters and organized figures were significantly different

between the study groups. Concerning organized letters; mixed cancellation strategy was preferred by subjects in ADHD-C group, while planned strategy style was used by ADHD-I group. Meanwhile in organized letter cancellation strategy, subjects in ADHD-I group mostly preferred planned cancellation style than the other three study groups. There is not any study to compare with in the literature. Observation during test administration indicated that, subjects in ADHD-I group were more introvert and calm; they preferred using cancellation strategy than just circling out targeted letters or figures. On the other hand, subjects in ADHD-C and especially ADHD-Comorbid group immediately started to circling out the target letters / figures without thinking thoroughly, and did not check their probable errors. So, observing the cancellation style might give good clue about subjects' planning ability as well as visual searching and scanning ability. Both random letters and random figures made subjects to leave out planned cancellation style.

4.6. Discriminant Analyses of Conner's Parental-Teacher Rating Scales, Child Behavior Check List, WISC-R and Executive Function Tests

The discriminating power of Conner's Parental-Teacher Rating Scales, Child Behavior Check List, WISC-R intelligence test, and a combination of EF tests, for classifying the study groups was investigated. Four study groups served as dependent variables, while all tests scores served as predicting variables.

The overall classification result of group membership was 74.8% for Conner's Parental and Teacher rating scales. Best predicting variables were CTR-H and CPR-H scales, explained in Function 1 with higher correlation rate. Concerning group centroids, function 1 was significantly discriminating Control group, ADHD-Comorbid and ADHD-C group, while CTR-I score was significantly correlated with function 2 and highly predicted the ADHD-I group. It means, that both parental and teacher ratings of hyperactivity, and teacher rating of inattentiveness were more accurately discriminating the groups. Hartman, Rhee, Erik, Willcutt, and Pennington (2007) in their study of rater disagreement for ADHD suggested that teachers might be more reliable reporters than parents. In addition, parents and teachers are observing different ADHD phenotypes in

children because they see children in different contexts, and teachers have the chance to experience many children at the same time and to compare the ADHD child with normal peers (AAP, 2000). The present results of discriminant analysis indicated that both teacher rating hyperactivity and inattentiveness are good predictors for ADHD symptoms as well as the parents' hyperactivity scores.

The overall classification rate of group membership in CBCL was 53.1%. Best predicting variables for Function 1 were attention problems, aggressive behavior, delinquent behavior and thought problems. In other words, externalizing problem behaviors were better as predicting variables for group memberships. Group centroids indicated that the function 1 was discriminating Control group better than the ADHD-Comorbid and ADHD-C groups. However, the correctly classified cases ratio was quite low. Therefore, discriminating power of CBCL was suspicious. In their discriminant classification trees study, Ostander, Weinfurt, Yarnold and August (1998), yielded that all of the scales significantly discriminated non-ADHD students from ADHD students; and anxious-depressed, social problems, attention problems, delinquent behavior, and aggressive behavior scales provided significant discrimination between the subtypes. Students without ADHD had lower scale scores on the social problems, aggressive behavior, and attention problems scales, while students with ADHD had higher scores on social problems and delinquent behavior. Concerning ADHD subtypes, aggressive behavior scale was slightly better at predicting ADHD-C students than ADHD-I students. Outcome of present study was concordant with these results: Subscales of attention problems, aggressive behavior, delinquent behavior and thought problems were significantly discriminating the Control group, the ADHD-Comorbid and ADHD-C group.

Discriminant analysis outcome of WISC-R subtest scores yielded a quite low discriminating level, and only 44.1% of subjects were correctly classified according to their original group membership. Therefore, it was not very convenient to say, that subtests of WISC-R would discriminate the ADHD and Control groups. Meanwhile, mazes, comprehension, information, digit span and block design were, highly correlated variables with Function 1; the group centroids

indicated that the first function was discriminating the Control group and ADHD-Comorbid group and ADHD-C group. Subscores of mazes, comprehension, information, digit span and block design were best predicting variables for discriminating the Control group, the ADHD-Comorbid and the ADHD-C group. This outcome was concordant with the literature (Barkley 1997; Mahone et al, 2003; Schunck, and Crinella, 2005)

Because of the excessive amount of EF variables, only variables that have significant correlation with CBCL, CPRS and CTRS scales were used for discriminant analysis. Same as the WISC-R subscales, the selected EF test scores had very low discriminating power for predicting group membership, and only 45.5% of subjects were correctly classified according to their actual group memberships. CVLT-C total recall list A, Bender-Gestalt Test, ToL number of total moves, WCST perseverative errors, WCST number of correct responses, and CT random figures omission errors were correlated with function 1. Group centroids indicated that function 1 was highly discriminating Control group, ADHD-comorbid group and ADHD-C group. All these EF variables were evaluated for assessing group differences in four study groups.

4.7. Summary and Conclusion

Before proposing the conclusion, having an overview of the outcome would give a clear picture. In this study three ADHD groups (ADHD-I, ADHD-C and ADHD-Comorbid), and a Control group were examined in terms of intelligence, behavioral problems, and executive functioning. Subjects in all groups were matched concerning FSIQ level, age, and sex.

Demographic characteristics indicated that, education level were high in the Control group mothers, and low in ADHD-Comorbid group fathers. More family members of ADHD-Comorbid group had history of ADHD, and the mothers of ADHD-Comorbid group stated having significantly more stressed pregnancies. The children in the ADHD-Comorbid group had low school achievements, problems in writing and were rejected by peers.

Concerning behavioral problems of subjects, the ADHD-I group mainly displayed internalizing problems, while ADHD-C and ADHD-Comorbid groups had externalizing problems, and all three groups had attention problems, thought problems and anxiety / depression, according to parental rating of CBCL.

The Control group had significantly better performance in verbal IQ, verbal subtest of comprehension, and performance subtest of mazes than the ADHD groups. In addition, children in ADHD-Comorbid group had lower scores in ACID and Freedom from Distractibility scores. Teacher rating inattentiveness scores were negatively related with VIQ, PIQ and FSIQ of subjects in ADHD-I group. On the other hand, teacher rating inattentiveness was positively related with VIQ and FSIQ of Control group subjects. Concerning ADHD-C group, only teacher rating inattentiveness had negative correlation with PIQ. No significant correlation was observed between IQ scores and parental, teacher ratings of inattentiveness and hyperactivity for subjects in ADHD-Comorbid group.

Relationship between Conner's Rating Scales, intelligence and EF indicated that subjects in ADHD-I group had deficits in tasks that required mental but not behavioral control such as set shifting. Their PIQ, FSIQ and teacher rating inattentiveness had negative correlation with WCST perseverative errors and perseverative responses. Correlation of internalizing and externalizing behavioral problems indicated more planning tendency in behavior. Introvert manner of ADHD-I subjects made them more patient, but they planned quite slowly.

ADHD-C group displayed an exceeding level of inattentiveness and externalizing characteristics, indicating disinhibition of thought and behavior. On the other hand, teacher's rating hyperactivity scores showed that subjects in ADHD-C group would not have problems with set-shifting or cognitive flexibility.

Inattentiveness of the ADHD-Comorbid group was related with problems in verbal learning or verbal encoding. In addition, parental rating of hyperactivity indicated that hyperactivity of the child was seen as a relatively positive behavior and was perceived as an improving factor in verbal learning and attention. Higher PIQ and FSIQ had a positive effect on audio-visual attention of subjects in ADHD-

Comorbid group, higher externalizing and total problem scores were related with more behavioral inhibition, but less inattentiveness.

In the Control group, excessive parental rating hyperactivity score was related to higher impairment in attention, interference and planning ability, while parental rating inattentiveness was related with weaknesses in verbal learning and verbal memory. In addition, teacher rating of inattentiveness indicated weakness in verbal learning and short term verbal memory while displaying no effect on visually copying shapes. Teacher rating hyperactivity was related with exceeding disinhibition. High PSIQ and FSIQ were related with improved short term verbal memory, and decreased disinhibiton. Internalizing problems were related with weaknesses in verbal learning and verbal memory, while externalizing was related with impairment in verbal learning, and disinhibition.

There were important differences of EF between the four groups: Concerning planning ability (ToL), only the Control group and ADHD-C and ADHD-Comorbid groups were significantly different, and Control group displaying better planning ability than the other two. Concerning set-shifting, cognitive flexibility, developing problem solving strategy (WCST), the Control group had better performances than the other groups in overall, but concerning statistically significant outcome, there was not a significant difference between ADHD-I group and Control group. Assessment of organized memory search, sustained production and semantic fluency (K-A-S and category fluency task) indicated that the four study groups were significantly different in category fluency-perseverative errors, and children in the ADHD-C group had significantly more perseverative errors than children in the ADHD-I and Control groups. Assessment of verbal learning memory and recalling verbal material (CVLT-C) showed that subjects in the ADHD-C and ADHD-Comorbid groups had more problems with verbal learning ability, auditory attention, long term memory and short term memory. Continuous Performance Test and Go / No-Go task was applied in the aim of assessing inhibitory control and attention. Outcome revealed that the ADHD- Comorbid group was significantly worse in attention domain than were the Control and ADHD-I groups. Stroop Color-Word TBAG version was

used to assess selective attention and response inhibition, and Stroop interference effect was observed in ADHD-Comorbid group. Stroop total time was significantly different between groups; the Control group used less time than the ADHD-C group. Cancellation Tasks were administered in the aim of assessing sustained attention and visual search. It was found that subjects in ADHD-Comorbid group and ADHD-C group showed lower sustained attention. Concerning cancellation style of subjects, the ADHD-I group mainly preferred to use planned cancellation style, regardless of appearance of task (organized versus random).

Discriminant analyses of findings with Conner's Rating Scales, CBCL, WISC-R and EF revealed that, Conner's parental and teacher ratings of hyperactivity were more accurately discriminating the groups, and the overall classification of group memberships was 74.8%. On the other hand, this outcome lied in the area of expectancies, as Conner's Parental and Teacher Rating Scales were used as selection instruments for group membership. Symptom subtest (attention problem, aggressive behavior, delinquent behavior and thought problems) of externalizing problem behaviors were the best predicting variables of CBCL, with a 53.1% overall group classification rate of group membership. WISC-R subtest scores yielded a quite low discriminating level, and only 44.1% subjects were classified correctly. Best predicting variables were mazes, comprehension, information, digit span and bloc design. Selected EF test scores had very low discriminating power for predicting group membership and only 45.5% of subjects were correctly classified. Best predicted variables of EF were CVLT-C total recall list A, Bender-Gestalt Test, ToL number of total moves, WCST perseverative errors, WCST number of correct responses, and CT random figures omission errors.

As it was mentioned before, executive functions constitute advanced cognitive processing such as planning, abstract reasoning, judgment, ability to solve novel problems, and goal directed behavior. According to previous researches EF is thought to be related with prefrontal / frontal lobes and need input from the rest of the brain (Romine, and Reynolds, 2005; Squire, Bloom, Mc Connell, Roberts, Spitzer and Zigmond, 2003). According to Frank (1996), children with

frontal lobe lesions have a tendency to abnormalities of impulse control, as well as abnormalities in motor activity and attention span. Thus when EF is impaired in children with ADHD, as to assume in witnessing of behavioral problems, it is reasonable to expect that in children with ADHD, frontal lobe deficits are evident (Davis, 2006). At this point we can refer to Barkley's (1997) theory of EF, basing on the assumption that behavioral inhibition is a central problem in ADHD and is connected with four executive functions; working memory, internalization of speech, self regulation of affect and reconstitution. Barkley's theory of EF, was evaluated thoroughly in the introduction section. Concerning Barkley's theory, these four EF's influence the motor system for pursuing a goal directed behavior. As Barkley (1997) states, children with ADHD-C type are characterized having poor behavioral control; they have problems with inhibition, poor organization capacity, impaired verbal problem solving and self directed speech, poor self regulation. Based on ADHD-C type behavioral characterization, Barkley postulated that only children with ADHD-C and ADHD-H display executive function deficits but not ADHD-I (Barkley, 1997; Tannock, 2003). On the other hand, children with ADHD-I type may represent a separate disorder, displaying more problems with selective attention, sluggish tempo, difficulties in reading, mathematics and language, and poor memory retrieval (Barkley, 1997).

Outcome of the present study mainly supported Barkley's EF theory of ADHD. The subjects in ADHD-C group displayed EF deficits in behavioral inhibition, sustained attention, impairment in verbal fluency-category shifting, perseveration, lower conceptual level of responses, difficulty in problem solving in a novel situation, verbal learning, long term verbal memory, lack of semantic clustering / organization of words, difficulty in verbal screening. In addition, ADHD-Comorbid (ADHD-C+ODD/CD) group displayed more severe impairments than ADHD-Combined group. Two recent studies in the aim of assessing the relationships between ODD and executive dysfunction via comparing subjects with ADHD, subjects with ADHD+ODD/CD, and subjects with ODD/CD, concluded that ODD/CD did not show higher impairments in EF. Subjects with ADHD+ODD/CD displayed more impairments than subjects with ADHD and subjects with ODD/CD

(Clark, Prior, and Kinsella, 2002; Clark, Prior, and Kinsella, 2002; Oosterlaan, Scheres, and Sergeant, 2005).

In the present study, the higher rate of EF impairment in ADHD-Comorbid children might be interpreted in connection with family characteristics. Their mothers had a more stressed pregnancy, did not plan having a baby, and the rate of ADHD in family members was the highest among the study groups. Davis (2006) postulates, that family environmental factors still continue to play an important role in shaping the comorbid disorders present in children with ADHD, even though ADHD has more neurogenetic basis than environmental cause,

The EF test performances of the ADHD-I children were almost similar to those of the children in the Control group. Teacher rating inattentiveness indicated that subjects in ADHD-I group had deficit in mental control but not in behavioural control, as Barkley (1997) also stated. On the other hand, teacher rating hyperactivity was related with poor verbal fluency, and poor planning.

Overall, in the present study, ADHD-Combined and ADHD-Comorbid type had more impairment in EF tests than ADHD-I and Control group. As it was mentioned above, the outcome partly supported Barkley's EF theory of ADHD, but some EF tests such as, Go / No-Go Task, CPT commission errors, Cancellation Tasks, Verbal Fluency Test, Stroop Test and Trail Making Tests, all mainly assessing behavioral disinhibition, interference and behavioral set-shifting were not significantly different between the groups. The reason for that might be, the monotonous structure of the test, so that subjects got bored as it was observed in CPT and Go / No-Go task. On the contrary some challenging tasks might have led to higher scores, so that the subjects made special efforts to achieve the final point (Mccarthy, and Warrington, 1990).

The non-significant aberrations, in other words normal range performances may be firstly due to the fact, that EF tests initially were developed to assess the effect of significant cerebral insults and may not capture mild cognitive impairments occurring within the context of neuropsychological development (Biederman, 2006). Secondly, some subjects might have underlying impairments, but might compensate them in the structured setting of laboratory measuring, even

when they may not able to do it in the less structured reality of life (Clark, Prior, & Kinsella, 2002)

Both parental and teacher rating on hyperactivity were highly correlated with Function 1. Externalizing behaviors of CBCL were highly correlated with function 1, and they served as good predicting variables. WISC-R and selected EF tasks were not very accurate for correctly classifying the groups. In other words, EF tests should not be used to make or rule out a diagnosis of ADHD. Multi source information such as teacher's and parent's reports and clinical assessment, as well as clinical observation might frame the diagnosis of ADHD.

Concordant to the aim of the study hypothesis, significant difference was observed in WISC-R VIQ scale scores, and subscale scores in four groups, with outcomes parallel to previous researches. Behavioral problems of subjects showed differences between the four groups. Significant relationships were observed between executive functions and, WISC-R, CBCL, Conner's Parental, Teacher rating scales. Mean values of EF tests / tasks were significantly different between the four study groups. Discriminating power of Conner's rating scales, CBCL, WISC-R and EF tests / tasks was assessed; and it was assumed that the EF test / tasks were not very correctly classifying / discriminating the groups.

4.8. Limitations and Suggestions for Future Research

Main limitation of present study was the lack of female subjects. Therefore, it was not possible to make a comparison in gender, and evaluate the outcome of ADHD in girls. Assessment of parents' personality, as well as family functioning would give more valuable and accurate information for understanding of subtype differences, and psychosocial characteristics of ADHD. Higher sample sizes and studies of EF in other comorbid conditions with or without the company of ADHD can also be more convenient for assessing and further differentiating of ADHD subtypes. An analysis of neuropsychological findings in relation to findings of neuroimaging methods such as fMRI and electrophysiological correlates can also be valuable to assess the main pathology in ADHD. Also features of ADHD follow-up with or without pharmacological treatment, especially with stimulants

and with psychosocial / psychotherapeutic interventions should be integrated into the neuropsychological studies about this not rare disease.

4.9. Clinical Implications

Clinical implications of the outcome for each ADHD group are as follows:

ADHD-I children were almost similar to those of the children in the Control group. Teacher rating inattentiveness indicated deficit in mental control but not in behavioral control. In addition, teacher rating hyperactivity was related with poor verbal fluency and poor planning.

The subjects in ADHD-C group displayed EF deficits in behavioral inhibition, sustained attention, impairment in verbal fluency-category shifting, perseveration, lower conceptual level of responses, difficulty in problem solving in a novel situation, verbal learning, long term verbal memory, lack of semantic clustering / organization of word, and difficulty in verbal screening.

ADHD-Comorbid (ADHDC+ODD/CD) group displayed more severe impairments than ADHD-C group.

Overall, ADHD-Combined and ADHD-Comorbid type had more impairment in EF tests than ADHD-I and Control groups.

The outcome partly supported Barkley's EF theory of ADHD, but some EF tests such as, Go / No-Go Task, CPT commission errors, Cancellation Tasks, Verbal Fluency Test, and Trail Making Tests, that are mainly assessing behavioral disinhibition, interference and behavioral set-shifting, were not significantly different between the groups.

Subjects' attitude during the assessment revealed differences between the groups; children in ADHD-I group were more slow in thought processes and reaction, were carefully, made a special effort to not making any mistake, frequently checking, whether they did it correct or not, and were more cooperative.

Subjects in ADHD-C group were fast, displayed immediate reaction without thinking. They had an idea that their responses were correct, but something was wrong with the rules of tests / tasks. They did not show signs of internal speech, and insight, were not questioning their responses during the assessment.

Subjects in ADHD-Comorbid group were more impulsive, reacted immediately without listening to the instructions. Instead of making strategic / planned movements, they insisted on making errors or left the task / test incomplete, especially in Tower of London Test and Wisconsin Card Sorting Test.

Subjects in the Control group were more planned, calm and patient. They were listening well to the instructions and developed movements in accordance to the instructions. Some of the children in the Control group were anxious about giving wrong responses. In addition, a few children had excessive perseveration and intrusion errors in California Verbal List Test in the aim of recalling more words than actual remembrances. It would be suggested that the parental demands of success were effective in this attitude.

The overall outcome of the present study indicated that the evaluation and treatment of each child needs special attention, taking into consideration the individual differences. Parental attitude and expectancy, family environment, as well as demands of the teachers and schools should also be taken in concern, in assessment of the neuropsychological profiles of children with ADHD, and in planning treatment strategies.

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APPENDICES

APPENDIX A

CONNERS' Anne-Baba Derecelendirme Ölçeği

Adı Soyadı :…… Doğum tarihi (çocuğun):...../…../…..

	hiçbir zaman	nadiren	**sıklıkla**	her zaman
1.Eli boş durmaz, sürekli bir şeylerle oynar. *(Tırnak, parmak, giysi gibi)*	( )	( )	( )	( )
2. Büyüklere arsız ve küstah davranır.	( )	( )	( )	( )
3. Arkadaşlık kurmada ve sürdürmede zorlanır	( )	( )	( )	( )
4. Çabuk heyecanlanır, ataktır.	( )	( )	( )	( )
8. Her an sataşmaya hazırdır.	( )	( )	( )	( )
9. Hayallere dalar.	( )	( )	( )	( )
11. Kıpır kıpırdır, tez canlıdır.	( )	( )	( )	( )
12. Ürkektir *(yeni durum, insan ve yerlerden).*	( )	( )	( )	( )
19. Hatalarını kabullenmez, başkalarını suçlar.	( )	( )	( )	( )
20. Kavgacıdır.	( )	( )	( )	( )
23. Söz dinlemez yada isteksiz ve zoraki dinler.	( )	( )	( )	( )
24. Başkalarına göre endişelidir	( )	( )	( )	( )
25. Başladığı işin sonunu getiremez.	( )	( )	( )	( )
26. Hassastır, kolay incinir.	( )	( )	( )	( )
27. Kabadayılık taslar, başkalarını rahatsız eder.	( )	( )	( )	( )
33. Ruh halinde ani ve göze batan değişiklikler olur.	( )	( )	( )	( )
34. Kurallar ve kısıtlamalardan hoşlanmaz ve uymaz.	( )	( )	( )	( )
37. Zora gelemez.	( )	( )	( )	( )
38. Diğer çocukları rahatsız eder.	( )	( )	( )	( )
39. Genelde hoşnutsuz bir çocuktur.	( )	( )	( )	( )
45. Aile içinde daha az kayrıldığını düşünür.	( )	( )	( )	( )
46. Övünür, böbürlenir.	( )	( )	( )	( )
47. İtilip, kakılmaya müsaittir.	( )	( )	( )	( )

APPENDIX B

CONNERS' ÖĞRETMEN DERECELENDİRME ÖLÇEĞİ

Adı- Soyadı (öğrencinin):..... Tarih :..../..../200

	Hiçbir zaman	Nadiren	Sıklıkla	Her zaman
1. Kıpır kıpırdır yerinde duramaz				
2. Zamansız ve uyumsuz sesler çıkarır.				
3. İstekleri hemen yerine getirilmelidir.				
4. Bilmiş tavırları vardır.				
7. Dikkati dağınıktır, uzun sürmez.				
8. Diğer çocukları rahatsız eder.				
9. Hayallere dalar.				
10. Somurtur, surat asar.				
11. Bir anı bir anını tutmaz. Duyguları çabuk değişir.				
14. Hareketlidir. Durmak, oturmak bilmez.				
15. Heyecana kapılıp, düşünmeden hareket eder.				
16. Öğretmenin ilgisi hep üzerinde olsun ister.				
17. Göründüğü kadarıyla arkadaş grubuna alınmıyor.				
18. Göründüğü kadarıyla başka çocuklar tarafından kolaylıkla yönlendiriliyor.				
21. Başladığı işin sonunu getiremez.				
22. Olduğundan daha küçük çocukmuş gibi davranır.				
23. Hatalarını kabul etmez, suçu başkalarının üzerine atar.				
26. Zorluklardan hemen yılar.				
27. Öğretmenle işbirliğine girmez.				

APPENDIX C

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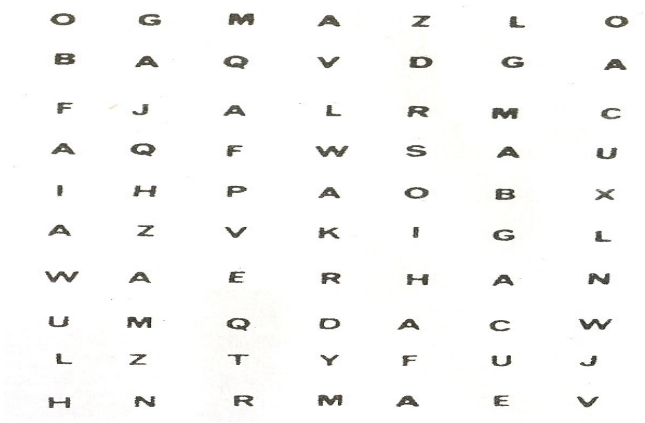
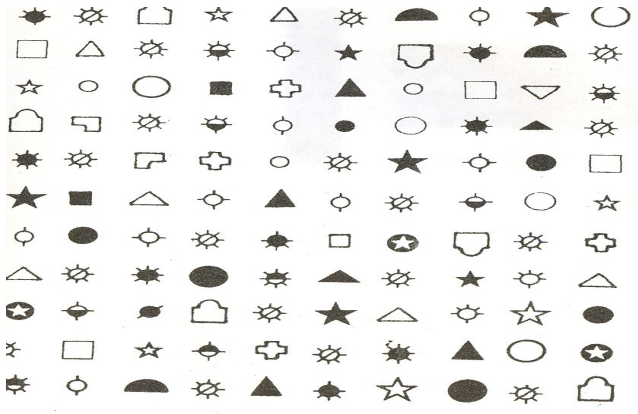
APPENDIX D

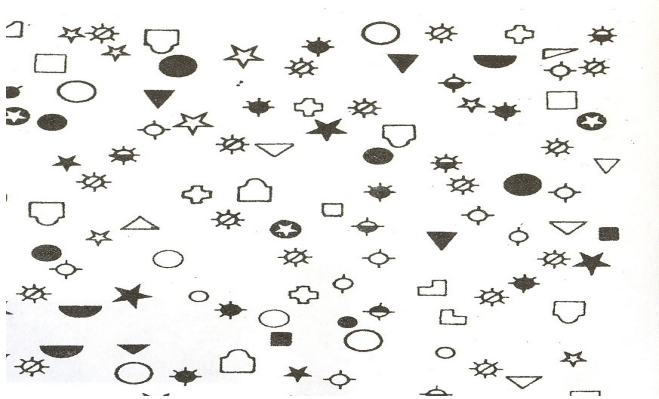


Cancellation Task Organized Letters

Cancellation Task Random Letters



Cancellation Task Organized Figures



Cancellation Task Random Figures

145

APPENDIX E

DİKKAT EKSİKLİĞİ / HİPERAKTİVİTE BOZUKLUĞU OLAN ÇOCUKLARDA YÜRÜTÜCÜ / YÖNETİCİ İŞLEVLER

1.Giriş

Dikkat Eksikliği / Hiperaktivite Bozukluğu (DEHB) sık rastlanan, erken yaşlarda ortaya çıkan nöropsikolojik / gelişimsel davranış bozukluğudur. DEHB kronik bir bozukluğun çocuğun okul ve ev yaşantısını olumsuz yönde etkilemektedir. Genellikle okul öncesi dönem veya ilkokul yıllarında tanı ortaya çıkmakta olup, dikkatsizlik, aşırı hareketlilik ve dürtüsellik karakteristik özellikleridir. Buna bağlı olarak DEHB'nda ortama uygun olmayan aşırı hareketlilik, tepkilerde aşırı dürtüsellik ve dikkatini bir konuya yöneltememe, sürekli dikkatini sürdürememe ve dikkatini bir noktadan diğerine geçirmekte problem yaşanmaktadır.

Hastalığın ortaya çıkma oranı %5 -10 arasında olabilmektedir. Buna bağlı olarak, yetişkin döneme taşınan DEHB oranı %3-5 olarak belirtilmektedir. Kız erkek oranı 3 -5 / olabilmektedir. DEHB semptomları bireyin sosyal, akademik ve iş yaşantısını olumsuz yönde etkileyebilmektedir. DEHB olan çocukların arkadaş ilişkilerinde sıklıkla problem yaşadığı gözlenmiş olup, arkadaşları tarafından dışlanma, arkadaşlarına fiziksel şiddet uygulama en sık rastlanan problemler arasında yer almaktadır.

DEHB tanısının konulmasında dikkatsizlik, aşırı hareketlilik ve dürtüsellik temel problemleri oluşturmaktadır. Bu problemler bağlı olarak DSM-IV- R'a göre DEHB'nun üç alt tipi vardır. Bunlar; DEHB – Dikkatsiz tip, DEHB – Hiperaktif tip ve DEHB – Bileşik tip olarak adlandırılmışlardır.

DEHB – Dikkatsiz tip tanısı alan çocuklarda gözlenen davranış problemler; görevi sonlandırmak için gerekli olan sürekli dikkati sağlayamama, yeni bir şeyi

öğrenmede güçlük yaşama, dışarıdaki seslerin dikkati kolaylıkla dağıtabilmesi, detaylara dikkat etmekte problem yaşama, dikkatsizce hatalar yapma, eşyalarını unutma veya kaybetme, öğrendiği bilgiyi kullanmakta zorluk yaşama, seçici dikkati kullanmada problem yaşama şeklindedir.

DEHB - Hiperaktif tip tanısı alan çocuklarda gözlenen belirgin davranış özellikleri; etrafta koşuşturma, gördüğü her nesneye dokunma, aşırı konuşma, sakin, hareketsiz oturmakta problem yaşama (sınıfta ders sırasında veya evde yemek yerken) şeklindedir. Aşırı dürtüselliğe bağlı olarak; ani tepkilerini kontrol etmekte zorluk yaşama, düşünmeden hareket etme, duygularını denetlemekte problem yaşama, davranışlarının sonuçlarını düşünmeksizin hareket etme ve sırasını beklemekte problem yaşama şeklindedir.

DEHB- Bileşik tip tanısı alan çocuklarda gözlenen davranış problemleri DEHB-I ve DEHB-H tip tanılarında gözlenen davranışlara ek olarak, sürekli dikkatini sağlamakta problem yaşama ve çelinirlik (distractibility) problemlerinin gözlenmesi şeklindedir.

DEHB etyolojik etmenleri arasında genetik, çevresel, fiziksel faktörler, beyin yapısı ve beslenme şekli yer alabilmektedir. DEHB ile birlikte görülebilen diğer psikiyatrik bozukluklar depresyon, anksiyete, karşı çıkma baş kaldırma bozukluğu, davranış bozukluğu, madde kullanımı olup, gelişimsel bozukluklar arasında yaygın gelişimsel bozukluğu, otizm, öğrenme güçlüğü olabilmektedir. DEHB'nun alt tiplerine göre gözlenen eş tanılı bozukluklara bakıldığında; DEHB-Dikkatsiz tipte, öğrenme güçlüğü, depresyon, duygulanım bozukluğu, konuşma problemi, içselleştirme problemleri şeklinde olup, DEHB-Bileşik tipte, davranış problemleri, karşı çıkma baş kaldırma bozukluğu, davranış problemleri, aile ve arkadaş ilişkilerinde problem yaşama, madde kullanımı, dışsallaştırma problemleri şeklindedir.

DEHB ve yürütücü işlevler arasında yakın bir ilişki olduğu literatürde belirtilmekte olup, yürütücü işlevler, yüksek düzeydeki bilişsel (kognitif) işlevler olarak tanımlanmış olup, tepki geciktirme, planlama, organizasyon, soyutlama, çalışma belleği, dikkati bir yönden başka bir yöne çevirebilme, sözel akıcılık, motor kontrol, duyguların düzenlenmesi, daha önceden kazanılmış bilgi ve

becerilerin uygun ortamda, hedefleri gerçekleştirebilmek için kullanılabilmesi yetilerini kapsamaktadır (Lezak, Howieson and Loring, 2004).

Barkley (1997), Hibrid modeli olarak tanımladığı teorisi ile, DEHB ve yürütücü işlevler arasında bir ilişki olduğu savunmuş olup, Hibrid modeline göre, tepkiyi geciktirememe, engelleyememe ve bozulmuş çalıma belleği DEHB'da yürütücü işlevlerin temel bozukluğunu oluşturmaktadır. *Çalışma belleği* kazanılmış bilginin uygun ortamda kullanılabilmesi, *kendilik denetlemesi (self regulation),* hedefe ulaşmak için gerekli olan dürtülerin denetlemesinde problem yaşama, yetersiz duygusal kontrol, *sözel çalışma belleği - içsel konuşma (internalization of speech)* öğrenmeye bağlı olarak davranışın düzenlenmesi, kuralların içselleştirilmesi, aktif problem çözümünde kuraları takip etmede problem yaşama, *yeniden yapılanma (reconstitution)* analiz ve sentezi kullanarak sözel veya sözel olmayan yeni, yaratıcı davranış kalıplarının geliştirilmesi. Buna göre Barkley (1997), DEHB'da gözlenebilecek olan yürütücü işlev bozukluklarının DEHB alt tiplerine göre farklılaşacağını belirtmiştir. Buna göre, DEHB- dikkatsiz tip tanısı alanlarda gözlenebilecek olan yürütücü işlev bozukluklarının görülebileceği fonksiyonlar, seçici dikkat, aşırı yavaşlık, kazanılmış bilgiyi getirebilme, matematik, dil bilgisi alanlarında problem yaşam şeklinde olabilmektedir. Öte yandan DEHB-Bileşik tip tanılı bireylerde gözlenen yürütücü işlev bozuklukları, davranışı kontrol edememe, engelleyememe, planlama yapamama ve uygun davranış geliştirememe, hatalar karşı duyarsız olma, organize olamama, kendini sözel olark ifade edememe, kurallara uymama şeklindedir. Özetle,Barkley'e göre, yalnızca DEHB-Bileşik ve DEHB- Hiperaktif alt tiplerinde yürütücü işlevlerde bozulma gözlenirken, DEHB- Dikkatsiz alt tipinde yürütücü işlev bozukluğu gözlenmemektedir.

Yukarıda verilen bilgiler doğrultusunda bu çalışmanın amacı;

Kontrol grubu ve DEHB gruplarının (DEHB-Dikkatsiz tip, DEHB-Bileşik tip, DEHB- Bileşik + Komorbid tip) WÇZÖ-R (Wechsler Çocuklar için Zeka Ölçegi-Revize) testi Sözel IQ, Perormans IQ ve Toplam IQ skorlarının yanı sıra Davranış problemlerinin her grup için değerlendirilip, grupların birbirleri ile karşılaştırılması.

Yürütücü işlevlerin; planlama, davranış kontrolü, çalışma belleği, kategori değiştirme değerlendirilip, kontrol grubu ve DEHB gruplarıyla kıyaslanması.

Yürütücü İşlevler puanlarının Conners Anne-Baba Derecelendirme (CADÖ) ve Conners Öğretmen Derecelendirme (CÖDÖ) ölçekleri dikkatsizlik, hiperaktivite puanları, WÇZÖ-R testinin Sözel, Performans, Total IQ puanları, Çocuk Davranış Değerlendirme Ölçeğinin (ÇDÖ) içselleştirme, dışsallaştırma ve total problem puanları ile olan ilişkisinin, Kontrol grubu ve DEHB grupları açısından ayrı ayrı ele alınması.

Yürütücü işlev testlerinin grupları ayrıştırma gücünün analiz edilmesi. Çalışmanın hipotezleri:

Hipotez 1*:* DEHB (DEHB-Dikkatsiz tip, DEHB-Bileşik tip, DEHB-Bileşik + Komorbid tip) tanılı çocukların CADÖ ve CÖDÖ dikkatsizlik ve hiperaktivite puanları, Kontrol grubundan anlamlı derecede farklı olacaktır.

Hipotez 2: Çocuk Davranış Değerlendirme Ölçeği puanları DEHB alt gruplarında Kontrol grubundan olumsuz yönde anlamlı derecede faklı olacaktır.

Hipotez 3: DEHB tanılı (DEHB-Dikkatsiz tip, DEHB-Bileşik tip, DEHB-Bileşik + Komorbid tip) çocukların WÇZÖ-R Sözel, P IQ puanı Kontrol grubundan anlamlı derecede farklı olacaktır.

Hipotez 4: CADÖ, CÖDÖ, dikkatsizlik ve hiperaktivite puanları, WÇZÖ-R sözel, Performans ve Toplam IQ puanları, Çocuklar için Davranış Değerlendirme Ölçeği (ÇDDÖ) İçselleştirme, Dışsallaştırma ve toplam problem skorları arasında her bir grup içinde pozitif / negatif ilişki gözlenecektir.

Hipotez 5: DEHB tanılı çocukların (DEHB-Dikkatsiz tip, DEHB-Bileşik tip, DEHB- Bileşik + Komorbid tip), yürütücü işlevleri ölçen test (çalışma belleği, davranış denetlenmesi, planlama, kategori değiştirebilme) sonuçları, kontrol grubundan anlamlı derecede farklı olacaktır.

Hipotez 6: Yürütücü işlevler test puanları DEHB alt grupları ve kontrol grubunu ayrıştırabilecektir (discrimination).

2. Metod

Katılımcılar

DEHB grubuna alınan çocukların seçim kriterleri;

- Her çocuğun ebeveyni DSM-IV-R tanı kriterine bağlı olarak DEHB, Karşı Gelme Baş Kaldırma Bozukluğu (KGBB), Davranış bozukluğu (DB) açısından değerlendirilmiştir.
- DEHB tanısı alan çocuklarda KGBB ve DB dışında bir başka psikiyatrik veya gelişimsel bozukluk olmamalıdır.
- Conners Anne-Baba Derecelendirme ölçeği ve Conners Öğretmen Derecelendirme Ölçeği DSM-IV-R bulgularını destekler nitelikte olmalıdır.
- Katılımcıların yaş dağılımı 6-11 arasında olmalıdır.
- Total IQ puanı 90 ve üzeri olmalıdır.

Kontrol grubu için seçim kriterleri;

- Ebeveyn ve öğretmenden alınan bilgiler doğrultusunda psikiyatrik veya gelişimsel bozukluk tanısı almamış olması.
- Conners Anne-Baba ve Öğretmen Derecelendirme Ölçeklerinin DEHB yönünde bulgu vermemesi.
- Yaş ve cinsiyet dağılımının DEHB grupları ile eşleştirilmiş olması
- Toplam zeka puanının 90 ve üzeri olması

Kontrol grubunda yer alan çocuklar çevre okullardan ebeveyn ve öğretmenin izni ile çalışmaya alınmıştır.

Çalışmaya DEHB toplam 111 çocuk katılmış olup grup dağılımı, DEHB-Dikkatsiz tip grubunda 37 çocuk, DEHB- Bileşik tip grubunda 37 çocuk ve DEHB-Bileşik + KBB/DB grubunda 37 çocuk şeklindedir. Kontrol grubunda toplam 36 çocuk yer almıştır. Çalışma grubunda yer alan çocuklar yaş, cinsiyet ve toplam zeka puanı açısından birbirleriyle eşleştirilmiştir.

2.1.Ölçekler:

Grupların ayrıştırılmasında ebeveyn ve öğretmen değerlendirmesini göz önüne almak amacı ile Conners Anne-Baba ve Öğretmen derecelendirme ölçekleri kullanılmıştır.

Çocukların davranış problemlerini ele almak, gruplar arasındaki davranış problemi paternlerinin farklılık ve ilişkilerini ele almak amacı ile Çocuk davranış değerlendirme Ölçeği kullanılmıştır. Çocukların davranış problemlerini ele almak amacı ile Çocuk Davranış Değerlendirme ölçeği (ÇDDÖ) kullanılmıştır.

Çocukların zeka düzeyini test etmek için Wechsler Zeka testi (WÇZÖ-R) kullanılmıştır.

Yürütücü işlevlerin farklı fonksiyonlarını test etmek amacı ile; planlama yeteneğini ve problem çözebilme becerilerini ölçen Londra Kulesi Testi, kategori değiştirme ve perseveratif tepkileri ölçen Wisconsin Kart Ayrıştırma Test, sözel yetenek, kısa-uzun süreli hafızayı ölçen Çocuklar için California Sözel Bellek Testi, sürekli ve seçici dikkati ölçmek amacı ile İşaretleme Testi, geçişmeyi (interference) ölçmek amacı ile Stroop Testi, Sözel Akıcılık Testi (K-A-S) ve Kategori Akıcılık Testi, çocukların sürekli dikkati ve dış uyaranlarla başa çıkabilme becerisini ölçmek amacı ile İz Sürme testi, sürekli dikkat ve seçici dikkati ölçmek amacı ile Sürekli Performans Testi, Dur-Durma Testi ve görsel dikkati ölçmek amacı ile Bender-Gestalt Testi kullanılmıştır.

3. Sonuç

İstatistiksel analizler yapılamadan önce datanın normallik analizleri yapılmış olup, aşırı uçlarda yer alan datalar analizden çıkarılmıştır. Ortaslamalr arası farkler Tek Yönlü Varyans Analizi ile test edilmiş olup, anlamlı çıkan grup ortalamalarında, gruplar arası farkı irdelemek için Tukey ve Duncan testleri kullanılmıştır. Kategorik değişkenler arasındaki farklılıklar Ki-kare testi ile analiz edilmilştir. Conners dikkat eksikliği, hiperaktivite puanları, zeka testi sonuçları,

davranış problemleri ve yürütücü işlevlerin gruplar içindeki ilişkilerini incelemek için Pearson korelayon analizi uygulanmıştır.

3.1. Demografik Özellikler

Demografik özellikler ele alındığında, Kontrol grubunda yer alan annelerin % 78'i planlı bir hamilelik yaşarken bu oran DEHB - Komorbid grubunda yer alan annelerde % 46 olarak saptanmış olup aradaki fark istatistiksel olarak anlamlı değildir. Öte yandan DEHB-Komorbid grupta yer alan annelerin %83'ü stresli bir hamilelik yaşarken, bu oran kontrol grubunda %49 olarak bulgulanmış olup, aradaki fark istatistiksel olarak anlamlıdır (Chi-kare (6, N=147)=19.89, p<.01). Buna ek olarak DEHB-komorbid ve DEHB-Birleşik tip tanılı gruplarda yer alan çocukların bebeklik dönemindeki uykularının DEHB-Dikkatsiz grup ve Kontrol grubunda yer alan çocuklardan anlamlı derecede daha az olduğu saptanmıştır.

Arkadaş ilişkileri ve okul başarısı göz önüne alındığında DEHB-Komorbid grupta yer alan çocukların gerek okul başarısı, gerekse arkadaş ilişkilerinde anlamlı derecede daha fazla problem yaşadığı saptanmış olup, yine bu grupta aile içinde DEHB görülme oranının diğer gruplardan daha yüksek olduğu saptanmıştır.

3.2. Conners Anne-Baba ve Conners Öğretmen Derecelendirme Ölçekleri, Wechsler Çocuklar için Zeka Ölçeği – Revize, Çocuk Davranış Değerlendirme Ölçeği

Conners Anne-Baba ve Öğretmen Derecelendirme ölçeklerinin sonuçları DSM-IV-R tanıları ile uyumlu olmuştur. Buna göre Kontrol grubunun dikkatsizlik ve hiperaktivite puanları diğer gruplardan anlamlı derecede düşük olup, tanı alma kriterlerinin altında kalmıştır. Buna ek olarak, DEHB-Dikkatsiz tip tanı grubunda yer alan çocukların yalnızca dikkatsiz puanları yüksek olup, hiperaktivite puanlarının düşük olduğu bulgulanmıştır.

Wechsler Çocuklar için Zeka Ölçeği – Revize (WÇZÖ-R) sonuçlarının yalnızca Sözel IQ puanı gruplar arasında anlamlı olup, Kontrol grubunun Sözel IQ puanı, DEHB-Komorbid bozukluğu olan gruptan anlamlı derecede daha yüksek olduğu saptanmıştır [F(3,143)= 3.12, p<.05]. Ayrıca Kontrol grubunun yargılama alt test puanı [F(3,143)=2.98, p<.05] ve labirentler alt test puanının [F(3,143)=

3.12, p<.05] DEHB-Komorbid grubunda yer alan çocuklardan anlamlı derecede daha yüksek olduğu saptanmıştır.

Çocuk Davranış Değerlendirme Ölçeği sonuçlarına göre, Kontrol grubu tüm alt ölçeklerde DEHB gruplarından daha düşük puan almış olup, ebeveynleri tarafından daha az problemli çocuklar olarak algılandıkları saptanmıştır. DEHB-Dikkatsiz tip grubunun içselleştirme [F(3,143) = 8.15, p<.000], somatizasyon [F (3,143) = 4.15, p<.01]ve içe dönüklük [F(3,143) = 3.50, p<.05]puanları diğer DEHB gruplarından daha düşük olarak saptanmıştır. Öte yandan DEHB-Komorbid ve DEHB-Birleşik tip tanılı grupların dışsallaştırma [F(3,143) = 27.17, p<.000] ve toplam problem [F (3,142) = 23.14, p<.000] puanlarının Kontrol grubu ve DEHB-Dikkatsiz tip tanılı gruptan daha yüksek olduğu saptamıştır. Anksiyete /depresyon, ve dikkat eksikliği puanları tüm DEHB gruplarında yüksek olarak bulgulanmıştır. Ek olarak, DEHB-Komorbid tip grubunda yer alan çocukların saldırgan davranış puanları diğer iki DEHB grubundan anlamlı derecede daha yüksektir [F (3,143) = 19.93, p<.000].

3.3. Yürütücü İşlevler Testleri

Yürütücü işlevleri ölçen test sonuçları gruplara göre ele alındığında, Kontrol grubu genelde tüm yürütücü işlev testlerinde daha iyi bir performans ortaya koyarken, DEHB-Dikkatsiz grubunda yer alan çocukların Kontrol grubuna benzer bir performans sergiledikleri gözlenmiştir. DEHB-Komorbid grupta yer alan çocuklar genel anlamda en bozuk performansa sahip olan çocuklar olarak bulgulanmıştır. Kısaca özetlenirse planlama yetisini ölçen Londra Kulesi Testinde, doğru cevap sayısı, toplam hamle sayısı ve başlama zamanı puanları açısından gruplar arasında anlamlı bir fark gözlenmiş olup, Kontrol grubunda yer alan çocukların toplam doğru cevap sayısı ve başlama zamanı performansının DEHB-Komorbid grubunda yer alan çocuklardan iyi olduğu gözlenmiştir. Buna ek olarak, toplam hamle sayısının DEHB-Birleşik tip ve DEHB-Komorbid tip tanılı gruplarda anlamlı derecede daha yüksek olduğu gözlenmiştir.

Wisconsin Kart Eşleme Testi sonuçlarına bakıldığında, toplam cevap sayısı, toplam yanlış cevap sayısı, doğru tepkiler, tamamlanan kategoriler, ve perseveratif hata sayısı değişkenlerinin gruplar arasında anlamlı derecede farklılık göstermiştir.

Buna göre, Kontrol grubunun bitirilen kategori ve doğru cevap sayısı puanı DEHB-Komorbid gruptan anlamalı derecede daha yüksek olup, aynı şekilde Kontrol grubunun perseveratif hata sayısı DEHB- Birleşik tip tanılı gruptan daha düşüktür.

Sözel akıcılık testi gruplar arasında anlamlı olarak farklılaşmamış olup, yalnızca kategori akıcılık perseverative cevap oranı DEHB-Birleşik tip tanılı grubunda, Kontrol grubundan anlamlı derecede daha yüksektir.

Kaliforniya Çocuklar için Sözel Öğrenme Testi sonuçlar; toplam hatırlanan kelime sayısı, kısa süreli geri çağırma, uzun süreli geri çağırma, kısa süreli ipucuyla geri çağırma, uzun süreli ip ucuyla geri çağırma, toplam karıştırma, toplam semantik bağlantılı öğrenme, öğrendiği bilgiyi doğru olarak tanımlama, ayrımlanabilirlik puanları gruplar arsında anlamlı derecede farklılık göstermiştir. tüm test puanları göz önün alındığında Kontrol grubu en iyi performansı gösteren grup olmuştur. DEHB-Birleşik tip ve DEHB-Komorbid tip tanılı grubun toplam hatırlanan kelime sayısı Kontrol grubu ve DEHB-Dikkatsiz tip tanılı gruptan anlamlı derecede daha düşük olarak bulgulanmıştır [$F(3,143) = 5.75$, $p<.001$]. DEHB-Komorbid grubunda, kısa süreli [$F(3,143) = 4.61$, $p<.01$], uzun süreli geri çağırma [$F(3,143) = 4.35$, $p<.01$] ve toplam karıştırma puanları [$F(3,143)=2.79$, $p<.05$] puanları kontrol grubundan daha düşük olmuştur. DEHB-Birleşik tip ve DEHB-Komorbid tip gruplarının semantik ilişkilendirme [$F(3,143)=5.07$, $p<.001$] ve ayrımlanabilirlik [$F(3,143)= 4.46$, $p<.01$]puanları kontrol grubundan anlamlı derecede daha düşük olması, DEHB gruplarında yer alan çocukların sözel öğrenmelerinin daha çok ezberlemeye yönelik olduğunu düşündürmektedir.

Sürekli performans testinin yalnızca komisyon hata puanı açısından gruplar arasında anlamlı fark gözlenmiş olup, DEHB-Komorbid grupta yer alan çocukların inhibisyon düzeylerinin kontrol grubundan daha kötü olduğu saptanmıştır [$F(3, 142)=4.74$, $p<.05$]. Dur /durma testi açısından gruplar arasında anlamlı bir fark gözlenmemiştir.

İnterferans etkisini ölçmek amacıyla uygulanan Stroop testi sonuçları DEHB-Komorbid grupta yer alan çocukların interferans kontrolünün Kontrol grubu ve DEHB-Dikkatsiz tip tanılı gruptan anlamlı derecede daha kötü olduğu bulgulanmıştır [$F(3,139)=2.58$, $p<.05$].

İz sürme testinin sonuçları gruplar arsında anlamlı bir fark göstermezken, Bender-Gestalt testi sonuçları DEHB-Birleşik tip ve DEHB-Komorbid tip gruplarının hata puanları, Kontrol grubu ve DEHB-Dikkatsiz tip grubundan anlamlı derecede daha yüksek bulgulanmıştır [$F(3,143) = 6.03$, $p<.001$].

İşaretleme testi sonuçlarına göre düzenli figürler bitirme zaman [$F(3,141) = 2.68$, $p<.05$], düzenli figürler doğru yanıtlar [$F(3,142) = 2.67$, $p<.05$], ve düzenli figürler yanlış yanıtlar [$F(3,142) = 2.64$, $p<.05$] gruplar arsında anlamlı farklılık göstermiş olup, DEHB-Birleşik tip grubunun performansı Kontrol grubundan anlamlı derecede daha düşük olmuştur. Aynı zamanda karışık şekiller doğru cevap [$F(3,142) = 2.98$, $p<.05$], ve hatalı yanıt [$F(3,142) = 2.98$, $p<.05$] puanlarına göre DEHB-Komorbid tip grubunda yer alan çocukların performansı Kontrol grubunda yer alan çocukların performansından daha yetersiz olmuştur. Ayrıca grupların işaretleme şekilleri birbirinden farklı olup, DEHB-Dikkatsiz tip grubunda yer alan çocuklar planlı işaretleme yöntemini benimserken diğer gruplarda yer alan çocuklar düzensiz işaretleme yöntemini benimseme eğiliminde olmuştur.

3.4. Yürütücü İşlevler Testleri ile Conners Anne-Baba ve Conners Öğretmen Derecelendirme Ölçekleri, Wechsler Çocuklar için Zeka Ölçeği – Revize, Çocuk Davranış Değerlendirme Ölçeği Arasındaki İlişkiler

DEHB-Dikkatsiz tip grubunda anne-baba ve öğretmenin Conners sonuçları farklı alanlardaki davranışları ölçtüklerini göstermekte olup, öğretmen daha çocuk çocuğun akademik yaşantısını değerlendirirken, anne-baba ağırlıklı olarak sosyal yaşantısını değerlendirmektedir. Öte yandan Wisconsin Kart Eşleme testi perseveratif tepkiler ve kategori değiştirme performans zeka ve total zeka ile negatif korelasyon göstermiştir. Öğretmenin hiperaktivite değerlendirmesi Londra Kulesi testinin doğru cevap sayısı ve başlama zamanı ile negatif korelasyon göstermiştir. Öğretmenin değerlendirdiği dikkatsizlik Wisconsin Kart Eşleme testinin (WKET) toplam yanlış sayısı ve perseverative hata sayısı ile pozitif korelasyon sağlamakla birlikte, kavramsal tepki oluşturabilme ile negatif korelasyon sağlamıştır.

ADHD-Birleşik tip grubunda, öğretmenlerin değerlendirdiği dikkat eksikliği, Sürekli performans testi (SPT) yok sayma puanı ile pozitif korelasyon sağlamıştır. Buna ek olarak dışsallaştırma ile sözel akıcılık testi kategori perseverasyonu ile ilişkili iken, toplam zeka düzeyi ve Dur/Durma testi yanlış tepki arasında pozitif korelasyon sağlamıştır. Öte yandan öğretmen tarafından değerlendirilen hiperaktivite puanı WKET perseverative yanıtlar ve perseverative hatalar ile negatif korelasyon göstermiştir.

DEHB-Komorbid tip grubunda, ebeveyn tarafından derecelendirilen dikkat eksikliği Kaliforniya Sözel öğrenme testinin ayrımlanabilme ve farkındalık (öğrendiği bilgi) puanları ile negatif korelasyon sağlamıştır. Ebeveynin değerlendirdiği hiperaktivite, işaretleme testinin karmaşık figürler bitirme süresi, Kaliforniya Sözel Öğrenme testi ayrımlama, karıştırma, ev toplam cevap sayısı ile pozitif korelasyon sağlamıştır. Bir anlamda bu grupta yer alan çocukların ebeveynleri çocuklarının aşırı hareketliliğinin özelikle sözel öğrenme ve motor performansları üzerinde olumlu etkisi olduğunu düşünmüşlerdir. Bu özellikle sınır koyma problemi ve ailesel problemlerin ön planda olduğu Karşı Çıkma Baş kaldırma bozukluğu olan çocuklar için önemli bir bulgu olmaktadır. Öğretmen tarafından değerlendirilen dikkat eksikliği bu grupta işaretleme testi karmaşık şekiller hata puanı ile pozitif korelasyon sağlamıştır. Dışsallaştırma ve toplam davranış problem puanları WKET kurulumu sürdürme, ile negatif korelasyon sağlarken, işaretleme testi karmaşık harfler puanı ile pozitif korelasyon sağlamıştır.

Kontrol grubunda yer alan çocuklarda; ebeveyn tarafından değerlendirilen dikkat eksikliği Kaliforniya Sözel Öğrenme testi toplam hatırlama, kısa ve uzun süreli geri çağırma, toplam perseveratif hatalar, semantik bağlantı kurma ve ayrımlanabilirlik ile negatif korelasyon sağlamıştır. Ebeveyn tarafından değerlendirilen hiperaktivite Kaliforniya Sözel Öğrenme testi toplam perseveratif hatalar ve Stroop testi enterferans süresi ile negatif korelasyon sağlamıştır. Öğretmen tarafından değerlendirilen dikkat eksikliği Kaliforniya Sözel Öğrenme testi toplam hatırlama, kısa süreli geri çağırma ve Bender-Gestalt testi toplam hata puanları ile negatif korelasyon sağlamıştır. Aynı zamanda öğretmen tarafından değerlendirilen hiperaktivite ile İşaretleme testi düzenli şekiller hata puanı arasında

pozitif korelasyon gözlenmiştir. Zeka testi puanları ve davranış testi puanları Kaliforniya Sözel Öğrenme testi ile korelasyon sağlamış olup, genel olarak sözel öğrenmedeki bozukluk ve inhibisyon yetersizliğine işaret etmektedir.

3.5. Ayırma (Discriminant) Analizi Sonuçları

Conners öğretmen hiperaktivite derecelendirme puanı (.67) ve Conners anne-baba hiperaktivite derecelendirme puanı (.67) birinci fonksiyonu en iyi açıklayan prediktörler olup, ikinci fonksiyonu en iyi açıklayan prediktör Conners öğretmen dikkat eksikliği derecelendirme puanı (.81) olmuştur. Grupların %74.8'i gerçek gruplarına göre sınıflandırılmıştır.

Çocuklar için Davranış Değerlendirme Ölçeğinin ayırma analizi sonuçlarına göre; birinci fonksiyonu en iyi predikte eden değişkenler, dikkat problemleri (.85), saldırgan davranışlar (.73), sapkın davranışlar (.55) ve düşünce problemleri (.44). olmuştur. İkinci fonksiyonu en iyi açıklayan değişkenler sosyal problemler (.40) olmuştur. Grupların %56.3'ü gerçek gruplarına göre sınıflandırılmıştır.

Wechsler Çocuklar için Zeka Ölçeği – Revize (WÇZÖ-R)'nin ayırma analizi sonuçlarına göre; birinci fonksiyonu en iyi predikte eden değişkeler, labirentler (.50), yargılama (.44), genel bilgi (.35), sayı dizisi (.35) ve küplerle desen (.25) olmuştur. Grupların %44.1'i gerçek gruplarına göre sınıflandırılmıştır.

Yürütücü işlevler testlerinin ayırma analizi sonucuna göre; yalnızca birinci fonksiyon anlamlı derecede açıklayıcı olmuştur ve birinci fonksiyonu en iyi predikte eden değişkenler, Kaliforniya Sözel Öğrenme testi toplam hatırlama (-.65), Bender-Gestalt Testi (.65), Londra Kulesi toplam hareket sayısı (.64), WKET perseveratif hatalar (.52), WKET doğru cevap sayısı (.49), ve işaretleme testi düzenli şekiller hata puanı (-.46) olmuştur. Grupların %45.5'i gerçek gruplarına göre sınıflandırılmıştır.

4.Tartışma

Bu çalışmada DEHB tanısı alan üç alt tip ile (DEHB-Dikkatsiz tip, DEHB-Birleşik tip, DEHB-Komorbid tip) kontrol grubunda yer alan çocuklar Conners Anne-baba, Öğretmen derecelendirme ölçekleri, Zeka testi, davranış testi ve yürütücü işlevler

açısından değerlendirilmiştir. Gruplardaki bütün çocuklar yaş, cinsiyet ve zeka puanı açısından bire bir eşleştirilmiştir.

Demografik özellikler göz önüne alındığında, DEHB-Komorbid grupta yer lan çocukların gerek okul başarısı, gerekse arkadaş ilişkileri açısından diğer gruplardan daha problemli olduğu bulgulanmıştır. Bu sonuç literatür ile uyumludur (Stawicki, Nigg and Eye, 2006; Biederman and Faraone, 2005).

Ebeveyn tarafından doldurulan davranış değerlendirme ölçeği sonucuna göre; davranış problemleri açısından en fazla sorun yaşayan grup DEHB-Komorbid grup olmuştur. Buna ek olarak DEHB-Dikkatsiz tipte yer alan çocuklarda daha çok içselleştirme, somatize etme ve içe dönüklük şikayetleri belirgin olmuştur (Barkley, 1997; Gadow et al. 2004; Jonsdottir, Bouma, Sergeant, and Scherder, 2006).. Saldırgan davranışlar DEHB-Komorbid grupta belirleyici olurken, DEHB-Birleşik tip ve DEHB-Komorbid tip gruplarda dışsallaştırma ve toplam problem puanları belirleyici olmuştur (Barkley, Du Paul, and McMurray, 1990). Kontrol grubunda belirgin bir davranış problemi gözlenmemiştir, bu durum literature ile uyumludur (Jonsdottir, Bouma, Sergeant, and Scherder, 2006; Barkley, Du Paul, and McMurray, 1990; Barkley, 1997).

Zeka testi sonuçları açısından sözel zeka puanı gruplar arasında farklılık göstermiş olup, aynı zamanda yargılama ve labirentler alt testleri anlamlı olarak farlı sonuç vermiştir. Kontrol grubunda yer alan çocukların performansı anlamlı derecede daha iyi olmuştur.

Yürütücü işlevleri ölçen test sonuçları ele alındığında, yapılan çalışma Barkley'in Hibrid teorisini destekler yönde bulgular vermiştir. Buna göre genel anlamda DEHB-Dikkatsiz tip grubunda yer alan çocukların yürütücü işlevler testlerinde gösterdikleri performans kontrol grubu ile benzerlik taşırken, bu grupta yer alan çocukların Barkley'in belirttiği gibi davranış inhibisyonu / kontrolü ve çalışma belleği alanlarında problem yaşamadığı gözlenmiştir. Öte yandan bu çocukların mental kontrol alanda problem yaşadıkları, daha yavaş düşünüp, yavaş tepkide bulundukları gözlenmiş olup, öğretmen tarafından derecelendirilen hiperaktivite puanı yetersiz sözel akıcılık ve yetersiz planlama yeteneği ile ilişkili bulunmuştur.

DEHB-Birleşik tip grubundan elde dilen yürütücü işlevler test sonuçları, yetersiz davranış inhibisyonu, sürekli dikkati sağlama güçlüğü, sözel kategori akıcılığında bozulma perseverasyon, yetersiz kavramsal tepki düzeyi, yeni ortamlarda problem çözmede sorun yaşama, uzun süreli sözel hafıza işlevlerinde yetersizlik, sözel olarak öğrendiği bilgiler arsında semantik ilişki kuramama şeklinde bulgular elde edilmiş olup, bu bulgular Barkley'in (1997)teorisi ile benzerlik taşımaktadır.

DEHB-Komorbid grupta yer alan çocukların yürütücü işlev testlerinden elde ettiği sonuçlar, DEHB-Birleşik tip tanılı gruptan daha bozuk olmuştur.

Kontrol grubunda yer alan çocukların yürütücü işlev testleri puanları ve performansları, testlere adaptasyonu normal diğer üç çalışma grubundan genel olarak daha olumlu ve başarılı olmuştur.

Özetle, DEHB-Birleşik tip ve DEHB-Komorbid tanılı grupta yer alan çocukların yürütücü işlev fonksiyonlarının DEHB-Dikkatsiz tip ve Kontrol grubunda yer alan çocuklardan daha bozuk olduğu saptanmıştır.

Bu sonuç kısmen Barkley'in DEHB yürütüvü işlevler teorisini desteklemekle birlikte, bazı yürütücü işlev testlerinde, (Dur / Durma Testi, Sürekli Performans Testi, İşaretleme Testi, Sözel Akıcılık Testi, İz Sürme Testi) gruplar arasında anlamlı fark bulunamamıştır. Bu testler genel anlamd davranış inhibisyonu ve kategori değiştirme yeteneğini ölçmektedir. Bu testlerin anlamsız çıkmasında farklı sebepler olabilir. Bunlardan bazıları; çocukların testsırasındaki olumlu veya olumsuz tutumu olabilir. Çocuklar bazı testleri ilgi çekici bulduklarında daha dikkatli ve ilgili davranabilmektedirler. Öte yandan bazı testlerde sıkılıp-özellikle Dur / Durma testinde- dikkatsizce davranabilmişlerdir.

Genel olarak DEHB-Birleşik tip tanılı çocuklar test sırasında çok hızlı hareket edip, düşünmeksizin ani tepkilerde bulunabilmişlerdir. Tepkilerinin doğru olduğunu düşünüp, olumsuz geri bildirim aldıklarında, testin kuralalrı ile ilgili bir problem olduğunu düşünmüşlerdir. Bu durum onların davranışları hakkında iç görü geliştirmede problem yaşadıklarını göstermiştir.

DEHB-Komorbid grupta yer alan çocuklar genelde aşırı derecede dürtüsel davranıp, testin talimatını dinlemeksizin hareket geçmişlerdir. Planlı ve organize

bir şekilde hareket etmek yerine hissettikleri gibi davranmayı tercih edip, sıklıkla hata puanı alacak tepkilerde bulunmuşlardır. Bu durumu en iyi yansıtan testler Londra Kulesi testi Wiskonsin Kart eşleme testi olmuştur.

Kontrol grubunda yer alan çocukların daha planlı, sakin ve sabırlı bir tutum içinde olmuşlardır. Bütün talimatları dikkatlice dinleyip, planlı hareket etmişlerdir. Hatalı davranışlarda bulunup, hata puanı almaktan kaçınmışlardır.

Genel olarak, yapılan çalışma DEHB olan her çocuğun bireysel olarak değerlendirilmesi gerektiğini, bireysel farklılıkların göz önünde bulundurulmasının zorunlu olduğunu göstermiştir. Ebeveynin beklentileri, istekleri, aile yapısı, okul ve öğretmenin beklentileri ayrıca dikkatli bir şekilde değerlendirilmesi gerekmektedir. Özellikle DEHB tanısı aln bir çocugun tanı ve tedavi kriterlerinin belirlenmesinde bu değişkenler önemli olmaktadır.

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Bahçivan-Saydam, Reyhan

Nationality: Turkish (TC)
Date and Place of Birth: 14 August 1965, Istanbul
Marital Status: Married
Phone: +90 212 495 27 59
email: rsaydam@istanbul.edu.tr

EDUCATION

Degree	Institution	Year of Graduation
MS	University of Reading	1992
BS	University of Istanbul	1988
High School	Plevne High School	1992

WORK EXPERIENCE

Year	Place	Enrollment
1993-Present	University of Istanbul, Medical Faculty of Istanbul, Child Clinic	Clinical Psychologist

FOREIGN LANGUAGES

Advanced English

HOBBIES

Swimming, Movies, Gardening, Cooking, Reading

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