COMPARING ATTENTIONAL SKILLS USING THE TEST OF EVERYDAY ATTENTION FOR CHILDREN SCORES IN A SAMPLE OF U.S. CHILDREN

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To the Dean of the Graduate School:

I am submitting herewith a dissertation written by Joy Grace Nicewander entitled "Comparing Attentional Skills Using the Test of Everyday Attention for Children Scores in a Sample of U.S. Children." I have examined this Dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of PhD with a major in School Psychology.

Daniel C. Miller, PhD, Major Professor

We have read this dissertation and recommend its acceptance:

Accepted:

Dean of the Graduate School

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ABSTRACT

JOY GRACE NICEWANDER, M.A.

COMPARING ATTENTIONAL SKILLS USING THE TEST OF EVERYDAY ATTENTION FOR CHILDREN SCORES IN A SAMPLE OF U.S. CHILDREN

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The aim of this study was to examine if demographic factors such as gender, ethnicity, and parental level of education contribute significantly to differences in attentional skills across children using the Test of Everyday Attention for Children (TEA-Ch). The TEA-Ch was administered to 158 children in the U.S. between the ages of 6 and 15 years, 11 months without identified attention problems. Participants were selected to match specified age, gender, ethnicity, and parent's education levels to approximate the 2005 U.S. Census data.

Using the TEA-Ch subtest scores as dependent variables, results revealed that there was no significant gender difference on sustained attention measures. Females scored significantly higher than males on a measure of selective attention (Map Mission) as well as on a shifting attention measure (Creature Counting). Parental level of education did not significantly affect performance on the TEA-Ch. In regards to ethnicity, Caucasians scored significantly higher than Hispanics on two measures of sustained attention (Score! and Score DT) and Caucasians also scored significantly

higher than African Americans on a sustained attention measure (Code Transmission). While many of the expected findings were not confirmed, the current study adds to the limited research base surrounding demographic variables and attention in a non-clinical population and also adds to the limited research exposure of the TEA-Ch in a U.S. population.

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CHAPTER I

INTRODUCTION

Attention has been the subject of much debate and research in the fields of psychology, education, and neuroscience for much of the last century. On the surface, attention seems like a fairly straightforward concept. As William James (1890) wrote in his textbook, *The Principles of Psychology*: "Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, and consciousness are of its essence" (p. 403-404). Despite the straightforward explanation, the study and measurement of attention has given rise to several complex, multidimensional conceptualizations of attention abilities. Furthermore, as the number of children diagnosed with attention problems increases across the United States and worldwide, researchers in the field of psychology strive to better understand attention and develop more precise diagnostic assessments of attentional skills (Evans, Morrill, & Parente, 2010).

One challenge encountered in the study and assessment of attention is that there is not a universally agreed-upon theory of attention. Researchers from various fields of psychology endorse different theories to explain the multi-faced area of attention. However, much neuropsychological research supports the existence of at least three attention subcomponents: sustained attention or vigilance, shifting attention, and selective attention or inhibition of response to irrelevant stimuli (Cooley & Morris, 1990). Each of these three areas of attention will be examined in detail in the next chapter.

Neuroimaging studies of the brains of children and adults are revealing much about the neuroanatomical basis of attention and are offering brain-based support of neuropsychological theories of attention (Raz, 2004). The frontostriatal circuitry, including the pre-frontal cortex and cingulate cortex, has been well-documented for its involvement in attention (Bush, Valera, & Seidman, 2005; Dickstein, Bannon, Castellanos, & Milham, 2006; Paloyelis, Mehta, & Kuntsi, 2007). Neuroimaging studies are also implicating other brain areas including the cerebellum and parietal lobe as being involved in attentional processes (Cherkasova & Hechtman, 2009; Nigg & Casey, 2005; Smith, Taylor, Brammer, Toone, & Rubia, 2006).

In addition to a lack of consensus on the theoretical aspects of attention, there are also no agreed-upon diagnostic instruments or standardized batteries for the assessment of attention. Tools used to measure attention can be divided into rating scales and performance measures. Rating scales are used to inventory behaviors related to inattention or hyperactivity that occur in a naturalistic setting (such as home or school) typically across a period of time, and are reliant upon the rater's opinion of the student's behavior.

Performance measures are standardized assessment tools used to evaluate specific attentional abilities and are actual samples of the student's behavior. Performance measures are completed in a classroom or laboratory setting and often use manipulatives such as paper and pencil, audiotape, or visual presentation via computer. Research indicates that scores on performance measures and scores on rating scales do not correlate highly, and one explanation for this discrepancy is that each requires a different form of analysis (i.e. cognitive and behavioral; Fletcher, 1998).

The diagnosis of attentional deficits by a physician or psychologist often relies upon behavioral rating scales completed by those familiar with the student's behavior, such as a parent or teacher. While these rating scales are valuable tools, they are typically intended to be used as screening instruments rather than the sole basis of diagnosis for attention problems. This is problematic as rating scales tend to be subjective in nature and relying on them solely in diagnosis of attention problems can lead to misdiagnosis. Disturbingly, a study of American medical doctors found that only 20% of the children they diagnose with ADHD Combined Type display hyperactive symptoms during the doctor's visit (Evans, Morrill, & Parente, 2010). The use of performance measures in conjunction with rating scales in the assessment of attention would make for a more thorough and standardized evaluation.

The need for thorough assessment of attention is becoming more critical each year, as the rates of ADHD continue to climb at a rapid rate. According to the Diagnostic and Statistical Manual of Mental Disorders: Text Revision (DSM-IV-TR), the diagnosis of ADHD requires the presence of hyperactive, impulsive, or inattentive features that have persisted for at least six months in at least two settings (American Psychiatric Association, 2000). The Center for Disease Control (CDC) recently reported that the percentage of children with parent-reported ADHD increased by 22% between the years

2003 and 2007 (Pastor & Reuben, 2008). As of 2007, approximately 9.5% of children between the ages of 4 and 17 had been diagnosed with ADHD (Pastor & Reuben, 2008). This is a marked increase from the 3-7% of school-aged children reported to have ADHD by the DSM-IV-TR, and highlights the dramatic increase in diagnosis in a few short years (American Psychological Association).

Early identification of attention problems and intervention to address attentional deficits is critical given the myriad of long-term social, behavioral, and academic implications of ADHD. Research indicates that children with a diagnosis of ADHD experience three times as many problems with peers (21.1% vs. 7.3%) as children without ADHD (Strine et al., 2006). Furthermore, children diagnosed with ADHD have an increased probability for delinquent behaviors, including stealing, using drugs, and getting in fights (Currie & Stabile, 2006). Children diagnosed with attention problems are at increased risk for grade retention and placement in special education, and their reading and math test scores are 8-10% lower than the national average (Currie & Stabile, 2006). In their 2006 examination of the effect of ADHD on educational outcomes, Currie and Stabile found the effects of ADHD to be much larger than the effects of chronic physical health conditions such as asthma on overall outcome.

The high rate of educational difficulties among children with attention deficits underscores the importance of early intervention to address behavioral and academic difficulties associated with the attentional problems. The use of assessment tools that measure different aspects of attention would assist in the development of interventions targeted at the specific area of attentional difficulty. While the majority of attention measures provide only a general attention score, The Test of Everyday Attention for Children (TEA-Ch) measures three different aspects of attention, providing specific information about a child's attentional strengths and weaknesses that could be used to develop targeted interventions (Manly, Robertson, Anderson, & Nimmo-Smith, 1999). A thorough description of the TEA-Ch as well as the utilization of the TEA-Ch in this study will be discussed.

In regards to demographic data, the majority of attention research has included middle-class Caucasian boys with ADHD as participants, resulting in limited research involving other demographic groups. The homogeneous participant group is problematic, as recent research indicates that between the years 2003 and 2007, the largest increases in parent-reported ADHD occurred in multi-racial children and children covered by Medicaid (Visser, Bitsko, Danielson, & Perou, 2010). The same study also found that the prevalence of ADHD among Hispanic children was 53% higher in 2007 than 2003, and similarly rates were significantly higher amongst children with a primary language other than English.

The lack of attention research concerning ethnic minorities is especially concerning in light of the changing demographics of American schools. In the fall of 2000, children from ethnic minorities made up 40% of the American public school population, and that number continues to rise (National Center for Education Statistics [NCES], 2002). Given the changing face of public education in the United States, more research examining the attentional skills of children from diverse ethnic and social backgrounds is needed.

Purpose of the Study

This research study was done in an attempt to add to the knowledge base regarding developmental and demographic differences in attentional skills in school-age children. The aim was to see if various factors such as gender, ethnicity, and parental level of education contribute significantly to differences in attentional skills across participants. By using the Test of Everyday Attention for Children (TEA-Ch) to evaluate three main elements of attention (i.e. sustained, shifting, and selective) in children ages 6 to 16 years old, the current research provides detailed data about attentional differences across various demographic variables.

Research Questions

While there is ample research examining gender and age-level differences in attention, there is limited research examining attention differences related to ethnicity or parental education level. Furthermore, a review of the literature found relatively few studies regarding attentional skills in children without ADHD or attention problems. Finally, the assessment of attention skills in children has traditionally relied upon information obtained from subjective measures such as behavior rating scales completed by parents or teachers. The current study used the TEA-Ch in an attempt to provide a standardized, objective assessment of specific elements of attention. Thus, the following research questions are addressed in this study:

1) Will the demographic factors of gender, ethnicity, and parental level of education contribute significantly to differences in sustained attention skills across participants?
2) Will demographic factors contribute significantly to differences in selective attention skills across participants?
3) Will demographic factors contribute significantly to differences in shifting attention skills across participants?
4) Will demographic factors be predictive of any of the nine subtest scores on the TEA-Ch?

Implications

Impaired attention is believed to be one of the most pervasive yet least understood disturbances in educational and neuropsychiatric settings (Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991). Despite rapid increases in ADHD diagnosis in recent years, particularly in children from ethnic minorities, very little is known about demographic differences in the attentional skills of school-age children. By using a standardized measure that yields information about multiple aspects of attention, this study will provide school psychologists and other school personnel greater insight into a child's attentional strengths and weaknesses. Having more detailed information about a child's attentional skills will aid in the development and implementation of interventions to address attentional deficits. Furthermore, the examination of demographic differences will add to the general knowledge base regarding attentional skills and to the various influences that may impact a child's attentional skills.

Important Definitions

For the purpose of this study the following definitions and clarification of terms will be used:

Attention: Attention refers to the cognitive ability to maintain focus and concentration. Types of attention include selective/focused, sustained, shifting, divided, and attentional capacity (Miller, 2007).

Selective Attention: Selective attention refers to the ability to select target information from distracters. Individuals must determine which elements are important and attend to those elements while ignoring irrelevant information (Manly et al., 1999).

Shifting Attention: Shifting attention refers to the ability to change the focus of attention smoothly and adaptively between one thing and another (Manly et al., 1999).

Sustained Attention: Sustained attention, or vigilance, is defined as the ability to maintain attention over an extended period of time (Betts, McKay, Maruff, & Anderson, 2006).

Test of Everyday Attention for Children (TEA-Ch): The TEA-Ch is a standardized and normed clinical battery of nine subtests designed to assess different components of attention in children and adolescents ages 6 to 16 years (Manly et al., 1999).

CHAPTER II

REVIEW OF THE LITERATURE

Theoretical and Neuroanatomical Basis of Attention

Theories of Attention

Colin Cherry was among the first modern-day psychologists to research auditory attention. Cherry used a dichotic listening paradigm, in which subjects listened to different auditory information in both ears and were asked to repeat the information heard from only one ear (Cherry, 1953). Cherry found that subjects were unable to repeat any of the speech details in the unattended ear. The selective auditory attention displayed in Cherry's experiment has been used to explain the cocktail party effect. The cocktail party effect refers to the ability to focus on a single voice or conversation while in a noisy environment with many other conversations taking place simultaneously (Cherry, 1953).

Donald Broadbent followed up Cherry's work on selective auditory attention and proposed a theory to explain Cherry's findings. Using dichotic listening tasks, in which subjects listened to one series of numbers in one ear and a separate series of numbers in the other ear, Broadbent proposed a filter model of information processing (Broadbent, 1958). The filter model refers to the idea that the brain has limited capacity for new auditory information, so irrelevant information is filtered out to allow for processing of the relevant information. Broadbent proposed that characteristics of the auditory information, such as loudness, importance, and novelty, determine which information is allowed through the filter. Broadbent's filter model is referred to as an early selection theory, as information is believed to be filtered out before being completely analyzed and processed for meaning. With his theory of information processing, Broadbent was among the first to propose that attention is a multidimensional cognitive construct and not a unitary ability.

Posner's work in the area of attention has done much to expand upon Broadbent's proposal of attention as a multidimensional construct (Posner & Boies, 1971; Posner & Peterson, 1990; Posner & Rafal, 1987). Posner and Boies coined the term "central limited processing capacity" to describe the idea that juggling two tasks at the same time is demanding. Central limited processing capacity is typically referred to as divided attention and is often measured through performance on dual tasks (Goldhammer, Moosbrugger, & Schweizer, 2007). Posner and Rafal proposed three attention senses: alertness, selective attention, and vigilance. Alertness refers to the general physical and mental state when one is prepared to respond. Selective attention refers to the processing of specific information while ignoring irrelevant stimuli. Vigilance refers to the mental effort that enables people to sustain attention over a long period of time. Posner and Rafal also proposed the concept of spatial attention, which involves the mental shifting of attention to a different target without moving the eyes. This orienting response is referred to as covert attention shift (Posner & Rafal, 1987). Posner and Peterson proposed the attention system of the human brain to include the following semiautonomous components: alertness, orienting (covert attention shift), and selection. Orienting, or covert attention shift, is typically evaluated using Posner's (1980) covert orienting task. This task typically involves visual target detection, and is measured by reaction time (Waszak, Li, & Hommel, 2010).

Mirsky and colleagues proposed a multidimensional theory of attention that included similar constructs as Posner and Peterson's (1990) attentional theory and further sub-divided attentional functions (Mirsky et al., 1991). Mirsky et al. conducted a factor analysis of neuropsychological test data from two samples: 203 adult neuropsychiatric patients and normal adult controls, and 435 elementary school children. Based upon the results of the factor analysis, which were very similar in the adult and child population, Mirsky and colleagues proposed the following four components of attention: focus-execute, sustain, encode, and shift. Two of the four components in Mirsky et al.'s model correspond to components of Posner and Peterson's theory: Mirsky's focus-execute component is similar to Posner and Peterson's selection system, and Mirsky's sustained attention is similar to Posner and Peterson's alertness component (Miller, 2007).

In Mirsky et al.'s (1991) factor analysis, four neuropsychological subtests loaded heavily on the focus-execute factor: Coding, Digit Cancellation, Trail Making, and the Stroop test. Each of these tasks required participants to visually scan material for a pre-determined target quickly and efficiently and then respond either verbally (Stroop test) or manually via paper/pencil (Coding, Digit Cancellation, and Trail Making). The Wisconsin Card Sorting Test, a classic neuropsychological measure, loaded on the Shift factor. Shifting attention refers to the ability to change the focus of one's attention flexibly and adaptively from one task to another. The Continuous Performance Test (CPT) loads heavily on the Sustain factor, which requires concentration over an extended period of time, or vigilance. Finally, Arithmetic and Digit Span loaded on the encode factor, and the authors explain that encoding tasks, "require sequential registration, recall, and mental manipulation of numeric information" (p.118).

As Mirsky and Posner researched attentional theories, a distinct yet overlapping strand of research investigated models of ADHD. In 1997, Barkley proposed that symptoms of ADHD, such as inattention, distractibility, and impulsivity, can be explained by executive functioning deficits. Barkley's comprehensive model of ADHD posited that pre-frontal lobe dysfunction results in deficits in behavioral inhibition, which leads to secondary deficits in other areas of executive functioning. Barkley reported that inhibition is measured on behavioral and cognitive tasks, rather than social activities and these tasks require delaying/withholding responses, stopping an ongoing response, and resisting distraction. The four areas of executive functioning that are negatively impacted by behavioral inhibition deficits include: working memory, internalization of speech, reconstitution, and self-regulation of affect-motivation-arousal (Barkley, 1997).

Working memory is defined as, "a limited capacity memory system that provides temporary storage to manipulate information for complex cognitive tasks such as learning and reasoning" (Miller, 2007, p. 209). In Barkley's (1997) model, working memory deficits observed in ADHD include hindsight/foresight, sense of time, and imitation of complex sequences. Internalization of speech is proposed to be delayed in children with ADHD, and internalization of speech is believed to lead children to greater self-guidance and self-control of behavior. The deficits observed in children with ADHD in self-regulation of affect, arousal, and motivation are believed to lead to over-arousal, or impulsivity, on some tasks and under-arousal on monotonous tasks. Reconstitution deficits in those with ADHD are reflected in difficulty with analysis and synthesis, as well sequencing tasks and behavioral flexibility. Barkley's model of ADHD offers support for the neuropsychological theories of attention as a multidimensional construct.

As indicated in the review of the various models of attention, there is much overlap but also disparity between the different models. Some of the disagreement stems from the lack of clear boundary between attention, executive functions, and memory (Lyone & Krasnegor, 1996). Executive functions encompass a number of cognitive abilities including self-monitoring, planning, strategizing, and behavior regulation (Miller, 2007). It is important to recognize that attention is encompassed as an executive function, although it is not always viewed as such (Lyone & Krasnegor, 1996). Furthermore, executive functions are broadly defined and it is not surprising that theories of attention overlap with different models of memory and executive functioning. For example, Mirsky's encoding component heavily overlaps with definitions of memory (Mirsky et al., 1991). Similarly, Barkley's (1997) model of behavioral inhibition in ADHD can be interpreted to relate to both attention and executive functioning. Despite the lack of consensus in theoretical attention models, brain imaging techniques are revealing a great deal about the neuroanatomical basis of attention.

Neuroanatomical Basis of Attention

Over the past few decades, much research has been done examining the brain areas associated with attention and those affected by disorders of attention. With the advent of non-invasive brain imaging procedures, researchers have been able to link neuropsychological theories of attention with the anatomical and functional aspects of attentional processes in the brain (Raz, 2004). In general, the frontostriatal circuitry, including the pre-frontal cortex, anterior cingulate cortex, caudate nucleus and putamen, has been implicated by much of the research as critical to attention, as has subcortical regions of the brain like the reticular activating system (Willis & Weiler, 2005). However, much variability and inconsistency exists in the research about the specific areas of the brain involved in specific attentional processes (Cherkasova & Hechtman, 2009; Valera, Faraone, Murray, & Seidman, 2007). This section will explore the brain areas reported to be associated with each theory of attention or attention deficit presented above (e.g. Posner and Mirsky) and will then examine neuroimaging results concerning attention.

In their 1991 proposed model of attention, Mirsky and colleagues linked each of their four elements of attention to brain structures implicated in each element. Mirsky and colleagues proposed that the area of sustained attention is dependent upon the brainstem and thalamic portions of the brain; specifically, midline and reticular thalamic nuclei and subcortical rostral midbrain structures, including the reticular formation, tectum, and mesopontine. In regards to the encode element, Mirsky et al. (1991) proposed that hippocampus and amygdala are involved in this area of attention, while the inferior parietal cortex, superior temporal cortex, and corpus striatum structures (e.g. putamen, caudate, and globus pallidus) were implicated in the focus-execute element of attention. Mirsky et al. proposed that the areas of the brain responsible for shifting attention include the dorsolateral pre-frontal cortex and anterior cingulate gyrus.

In their proposed model of attention, Posner and Peterson (1990) offered brain areas linked to their three areas of attention: orienting, selection, and alerting. Posner and Peterson proposed that the orienting system is governed by posterior brain regions, including the posterior parietal lobe, superior colliculus, and the lateral pulvinar nucleus of the posteriolateral thalamus. The selection system, which is similar to Mirsky's focus-execute system, was proposed to be linked to anterior cingulate and supplemental motor areas. The alerting system, which corresponds to Mirsky's sustained attention, was proposed to be linked to the right side of the brain, especially the anterior, pre-frontal regions.

Neuroimaging studies, using techniques such as positron emission tomography (PET), magnetic resonance imaging (MRI), and functional magnetic resonance imaging (fMRI) have advanced our understanding of the brain areas involved in attention and the areas affected by attention deficit disorders. The frontostriatal circuitry, including the dorsolateral pre-frontal cortex, ventrolateral pre-frontal cortex, dorsal anterior cingulate cortex, as well as the putamen and the caudate nucleus, has attracted a great deal of research attention in regards to its involvement in attention (Bush et al., 2005; Dickstein et al., 2006; Paloyelis et al., 2007). These regions of the brain are responsible for higher-order cognitive processes, such as executive function, attention, and the ability to inhibit responses (Raz, 2004). A meta-analysis of 16 neuroimaging studies found significant patterns of hypoactivity in frontal brain regions and basal ganglia of individuals with ADHD (Dickstein et al., 2006).

In regards to structural findings, the majority of studies indicate pre-frontal volume and cortical thickness reductions, as well as reduced volume in the caudate nucleus and pallidum (Cherkasova & Hechtman, 2009). Numerous fMRI and PET studies have examined brain functions in individuals with ADHD when engaged in a cognitive task. The most common cognitive activities used in neuroimaging studies include go-no-go tasks, continuous performance tasks, and variations of the Stroop test (Cherkasova & Hectman, 2009). Studies measuring neural activity in individuals with ADHD using such cognitive tasks have consistently found reduced activation in the frontal regions, dorsolateral anterior cingulate cortex, and striatum (Cherksasova & Hechtman, 2009).

In a study using PET scans to measure brain activation in adult males without ADHD on an auditory continuous performance task, researchers found activation in the mesial and anterior parts of the right prefrontal cortex and the bilateral anterior cingulate (Benedict, Lockwood, & Shucard, 1998). An fMRI study comparing children with ADHD to typically functioning controls on a response inhibition task found that children with ADHD had less striatal activation (Vaidya, Austin, & Kirkorian, 1998). A similar study comparing adolescents with ADHD to typically functioning controls on a response inhibition task found that compared to controls, adolescents with ADHD showed reduced activation of the medial prefrontal cortex, right inferior prefrontal cortex and left caudate nucleus (Rubia et al., 1999).

In addition to the frontostriatal circuitry, recent neuroimaging studies have implicated the cerebellum in attention and attention deficits (Hutchinson, Mathias, &

Banich, 2008; Nigg & Casey, 2005). Although the cerebellum has traditionally been thought of as a structure involved in motor control activities, researchers now believe that the cerebellum plays a role in higher order cognitive processes such as shifting attention, working memory, emotional regulation, and temporal information processing (Nigg & Casey; Middleton & Strick, 2001; Schmahmann, 2004). In regards to structural abnormalities, Castellanos and colleagues (1996) found in an MRI study that boys with ADHD had significantly smaller cerebellums than boys without ADHD. In a meta-analysis of 21 studies examining structural imaging findings in ADHD, Valera and colleagues found the largest differences between individuals with ADHD and controls in cerebellar regions, the splenium of the corpus callosum, total and right cerebral volume, and right caudate (2007). Valera, Faraone, Biederman, Poldrack, and Seidman (2005) found that compared to control participants, adults with ADHD showed reduced activation in the left cerebellum during performance on a verbal working memory task. Valera and colleagues (2007) summarize the strong implications of cerebellar involvement in attention with, "Though it is common for ADHD research to focus on frontal and frontal-striatal regions, these meta-analysis results emphasize the need to provide equal attention to other regions such as the cerebellum and the splenium" (p. 1367).

In addition to the cerebellum, recent research implicates parietal regions in attention and attention deficit disorders (Dunston et al., 2007; Tamm, Menon, & Reiss, 2006). Certain functions of the parietal regions, including the somatosensory cortex, posterior attentional system, sensory integration area, and dorsal stream of the visual system are thought to be related to ADHD dysfunction. In regards to structural abnormalities, meta-analytic reviews have revealed parietal volume reductions in ADHD including gray and white matter reductions, cortical thickness, and overall volume reductions (Cherkasova & Hechtman, 2009; Willis & Weiler, 2005). Studies reporting differences in parietal functioning primarily focus on boys with ADHD and healthy controls on executive functioning tasks. On an inhibition task, activation of the precuneus, posterior cingulate, and other temporoparietal areas have been reported in control participants during inhibition failures, suggesting that these brain areas are involved in error detection and performance monitoring (Dunston et al., 2007). Decreased activation of these temporoparietal areas are reported in ADHD boys during inhibition failures, suggesting that boys with ADHD have deficits in performance monitoring (Dunston et al., 2007).

Parietal activity reductions have also been reported during response switching in adolescents with ADHD (Smith et al., 2006) and during interference tasks in children with ADHD (Vaidya et al., 2005). Reduced parietal activity was also noted during a motor task, in which children with ADHD had decreased activation of the right superior parietal lobe during a sequential finger-tapping task (Motstofsky et al., 2006). In a meta-analytic review, reduced parietal activity has been reported in other tasks requiring attentional processing, including mental rotation, backward digit span, target detection, and visual selective attention (Cherkasova & Hechtman, 2009).

While the frontostriatal circuitry is well-supported by research as being involved in attentional processing, other brain areas, such as the cerebellum and parietal lobe, have received a great deal of attention for their role in attention and attention deficits (Bush et al., 2005; Cherkasova & Hechtman, 2009; Dickstein et al., 2006; Nigg & Casey, 2005; Paloyelis et al., 2007). Perhaps the variability of brain areas implicated in specific attentional constructs in neuroimaging studies can be attributed to differences in participants (i.e. ADHD vs. non-ADHD, child vs. adult) as well as differences in the neuroimaging techniques. Furthermore, attention is a complex, multi-faceted construct that underlies many higher-order brain functions, so it is logical that many brain areas are implicated.

Neuroimaging studies have offered support for theorized models of attention as a multidimensional construct. However, research indicates that tests that evaluate attentional abilities typically access only one aspect of proposed attention models (Cooley & Morris, 1990). Despite the widespread consensus among researchers that attention is a multidimensional construct, there are surprisingly few assessment tools that evaluate multiple components of attention. As Heaton et al. (2001) point out, "A measure that is reliably able to assess various components of attention would allow clinicians to more comprehensively assess specific attentional impairments. Such a measure also would allow researchers to further evaluate the relationship between specific attentional deficits and hypothesized…neuroanatomical substrates" (p. 252). The Test of Everyday Attention for Children (TEA-Ch) evaluates multiple components of attention, and as such has considerable potential as a comprehensive measure of attention in children.

The Test of Everyday Attention for Children

Theoretical Basis and Development

The TEA-Ch was developed as an adaptation of the Test of Everyday Attention (TEA), an adult battery designed to measure various components of attention in adults (Manly et al., 1999; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996). The TEA was designed to offer a valid assessment of attention in individuals aged 18 to 80 years with some form of acquired neurological insult or attentional deficit (Robertson et al., 1996). The TEA is an operationalization of Posner and Peterson's (1990) theoretical framework of attention, and each subtest is designed to simulate real-life tasks. The TEA has 3 parallel versions, each composed of 8 subtests measuring 3 aspects of attention: sustained attention, divided attention, and attentional switching (Chan, Lai, & Robertson, 2006).

The TEA demonstrates sufficient reliability, with test-retest correlation coefficients ranging from .61 to .90, and each subtest was sensitive to differences between stroke victims vs. typically functioning control adults (Robertson et al., 1996). In regards to validity, Robertson et al. (1996) examined the factor structure of the test using principal component analysis and derived a 4-factor model of attention from a group of healthy adults ($n = 155$). The 4 identified factors were sustained attention (Lottery Test, Elevator Counting, Dual Task Decrement), attentional switching (Visual Elevator), visual selective attention (Map Search, Telephone Search), and auditory-verbal working memory (Auditory Elevator with Reversal, Auditory Elevator with Distraction). However, a follow-up study with a sample of 133 Chinese participants used confirmatory factor analysis, thought to be more statistically stringent than principal component analysis, and produced a 3-factor model of attention (Chan et al., 2006). The 3-factor model included selective attention, sustained attention, and switching attention, and aligned with the Posner and Peterson (1990) framework of attention on which the TEA was based.

In 1999, Robertson and Nimmo-Smith, two of the authors of the TEA, collaborated with their colleagues Manly and Anderson, to develop a similar measure to the TEA to be used with children. The goal of the TEA-Ch is similar to that of the TEA, in that both tests include a variety of activities designed to evaluate numerous attentional capacities. In developing the TEA-Ch, the authors relied upon existing models of attention, such as Posner and Peterson's (1990) framework and Mirsky et al.'s (1991) model, as well as neuroimaging results (Manly et al., 1999).

Neuropsychological models of attention as well as neuroimaging research support the existence of at least three distinct components of attention: sustained, shifting, and selective. The TEA-Ch is normed for children ages 6-16, and it consists of nine game-like subtests designed to assess the three main components of attention listed above. Using structural equation modeling, the authors of the TEA-Ch presented a 3-factor model with a close fit to the data (Manly et al., 1999). Five subtests evaluate the factor of sustained attention while two subtests each assess the factors of selective attention and shifting attention. Each subtest will be fully explained in Chapter 3.

The TEA-Ch offers many potential advantages when compared to other existing attention measures. As mentioned above, the TEA-Ch is theory-driven and assesses multiple components of attention, which distinguishes it from most other attention measurements. For example, the Continuous Performance Test only evaluates sustained attention, and the Wisconsin Card Sorting Test only assesses shifting attention (Heaton et al., 2001). Neuroimaging studies have indicated that different brain systems are involved in different components of attention, suggesting that poor performance on one attentional component does not necessarily indicate a global deficit of attention. Furthermore, many childhood disorders, ranging from ADHD to Traumatic Brain Injury to Post Traumatic Stress Disorder, can result in attention abnormalities (Anderson, Fenwick, Manly, & Robertson, 1998; Barkley, 1997; Condor & Nursey, 1998). The pattern of attentional deficits can differ depending on the disorder, and as such a comprehensive test like the TEA-Ch is useful for its measurement of multiple attention components.

Another benefit of the TEA-Ch is that it uses various sensory modalities during administration, including auditory, visual, and motor (Manly et al., 1999). This is an improvement over other neuropsychological measures of attention, which traditionally only utilize visual stimuli (Cooley & Morris, 1990). Furthermore, the TEA-Ch authors attempted to minimize potentially confounding factors such as language, memory, intelligence, and motor speed, resulting in a more pure measure of each attentional component (Manly et al., 1999). Finally, the game-like format of the TEA-Ch is designed to engage children during administration, and each subtest is designed to simulate real world attentional demands, offering a more ecologically valid measure of attention (Anderson et al., 1998).

A number of research studies have utilized the TEA-Ch with a variety of clinical samples. Anderson et al. (1998) used the TEA-Ch to investigate attentional skills following a Traumatic Brain Injury (TBI) in childhood. Results indicated that the TEA-Ch was sensitive to attentional deficits in 18 children with a TBI compared to 18 age-matched healthy controls, with children who sustained a moderate to severe TBI demonstrating significant deficits in sustained and divided attention.

Numerous studies have used the TEA-Ch to compare attentional skills in children with ADHD and non-ADHD controls. Manly and colleagues (2001) compared the performance of 24 children with ADHD to 24 IQ-matched controls on six subtests of the TEA-Ch. Results indicated that children with ADHD performed significantly worse on measures of sustained attention and shifting attention, but there was not a significant group difference on the selective attention measure. Sutcliffe, Bishop, and Houghton (2006) examined 18 children with ADHD using four subtests of the TEA-Ch when on and off stimulant medication. Their performance was compared to 18 age-matched controls. Results were consistent with Manly et al.'s (2001) findings, in that children with ADHD demonstrated significant deficits in sustained and shifting attention when off stimulant medication. When the ADHD group was on stimulant medication, no significant group differences emerged between them and the control group with the exception of the Walk, Don't Walk subtest (a measure of sustained attention). These results suggest that the TEA-Ch is sensitive to changes in stimulant medication in children with ADHD.

In contrast to Manly et al. (2001) and Sutcliffe et al. (2006), Villella, Anderson, Anderson, Robertson, and Manly (2001) failed to find a statistically significant difference between an ADHD group and control groups on sustained attention tasks using the TEA-

Ch. However, Heaton et al. (2001), utilizing a larger sample size of 63 children with ADHD and 23 children without ADHD found that children with ADHD performed significantly worse than the control group on measures of sustained and shifting attention. This finding is consistent with the majority of research utilizing the TEA-Ch with ADHD populations and suggests that the TEA-Ch is sensitive to attentional deficits unique to ADHD.

Sustained Attention

Sustained attention, or vigilance, is defined as the ability to maintain attention over an extended period of time (Betts et al., 2006). The majority of research has utilized various versions of a continuous performance test (CPT) to evaluate sustained attention. The typical CPT paradigm requires participants to sustain attention to various visual or auditory stimuli for an extended period of time and respond to target stimuli when they appear and sometimes refrain from responding to non-target stimuli (Heaton et al., 2001). McKay, Halperin, Schwartz, and Sharman (1994) were among the first to examine sustained attention in children. Using a CPT with typically functioning children ages 7 to 11 years, the researchers found that across all ages, sustained attention tended to deteriorate over time on task. The developmental trajectory of sustained attention will be discussed in further detail in the next section.

In addition to the studies examining the developmental trajectory of sustained attention, numerous studies have examined sustained attention in children with ADHD. A review of the literature indicates that children with ADHD consistently have more errors overall on CPT tasks when compared to control participants (Corkum & Siegel, 1993; Seidel & Joshko, 1990; Stins et al., 2005). Stins et al. (2005) used a CPT paradigm to investigate sustained attention in 34 12-year-old boys with ADHD Combined Type and 28 healthy 12-year-old boys. They found that boys with ADHD performed significantly slower, less accurately, and more impulsively than control boys.

Some researchers examining sustained attention in children with ADHD have reported that performance declines over time on task (Epstein et al., 2003; Siedel & Joshko, 1990). Such researchers hypothesized that children with ADHD lose interest in the task as the novelty of the task wears off, whereas children without ADHD take longer to lose interest in the task. However, numerous other studies investigating sustained attention in children with ADHD have found that both the ADHD groups and the control groups become less accurate over time (Stins et al., 2005; Van der Meere & Sergeant, 1988). Stins et al. (2005) found that the rate of increase in errors was the same for both the ADHD and control groups, as there was no interaction between time on task and group with respect to accuracy on the CPT paradigm.

Shifting Attention

Shifting attention refers to the ability to change the focus of attention smoothly and adaptively between one stimulus and another (Manly et al., 1999). The Wisconsin Card Sorting Test (WCST) is often used to assess attentional shift, or the ability to shift sets, in school-aged children and adults (Grant & Berg, 1948). Much of the research surrounding shifting attention has focused on ADHD, and the results concerning shifting attention in children with ADHD are somewhat inconsistent. In a review of 13 studies using the WCST in ADHD samples, Barkley, Grodzinsky, and DuPaul (1992) reported that 8 studies found significant deficits in children with ADHD compared to controls, especially on areas hypothesized to be most sensitive to frontal lobe deficits (perseverative errors, perseverative responses, and number of categories completed).

Heaton et al. (2001) used the Opposite World and Creature Counting subtests of the TEA-Ch to examine shifting attention in 63 children with ADHD and 23 non-ADHD control children. Results indicated that children with ADHD performed significantly worse on both shifting attention subtests compared to the control group. These findings are inconsistent with those of Lajoie et al. (2005), who did not find significant differences between the ADHD and control groups on the Creature Counting subtest of the TEA-Ch.

Selective Attention

Selective attention refers to the ability to select target information from distracters. Individuals must determine which elements are important and attend to those elements while ignoring irrelevant information (Manly et al., 1999). Tasks that have traditionally been used to assess selective attention in children include the Stroop test, perceptual matching tasks (i.e. same/different judgment), central-incidental learning tasks (i.e. visual distracter tasks), and speeded classification tasks (Brodeur & Pond, 2001). Similarly to shifting attention, much of the research surrounding selective attention is completed using children with ADHD as participants. The current literature base on selective attention in children with ADHD suggests that there is no difference between children with ADHD and non-ADHD control groups on selective attention tasks, including Hooks, Milich, and Lorch (1994) using a speeded classification task, and

Dalebout, Nelson, Hletko, and Frentheway (1991) using a selective auditory attention task.

Several studies on selective attention in children with ADHD have found that results vary based on the nature and the demands of the task. Landau, Lorch, and Milich (1992) studied selective attention in boys with and without ADHD using a task where the boys watched a television show with and without distraction and then answered questions about the show's content. Boys with ADHD paid less attention to the show in the presence of distracters but interestingly their recall of the show's content did not vary significantly from the boys without ADHD. Ceci and Tishman (1984) found that children with ADHD performed more poorly then control children on a central-incidental learning task only when the encoding demands were high. Brodeur and Pond (2001) compared selective attention in children with ADHD and typically functioning controls using a computer task in which children identified visual target stimuli under several distracter conditions. The distracters varied based on task relevance (meaningful vs. irrelevant) and modality (visual, auditory, or both). Brodeur and Pond (2001) found that children with ADHD performed worse than control children on the selective attention task regardless of the distracter condition.

Based on a review of the literature concerning sustained, shifting, and selective attention, it is clear that relatively few studies have examined the different aspects of attention in typically-developing children; instead, the bulk of the research focuses on children with ADHD. Few studies to date have been completed with typically functioning children from various demographic groups to look for differences in these three subtypes of attention. In the next section, the developmental trajectory of overall attention will be discussed, as well as a review of the literature concerning the development of each subtype of attention (i.e. sustained, shifting, and selective). Literature surrounding other demographic factors, such as gender, parental education level, and ethnicity, in relation to attention will also be reviewed.

Demographic Factors and Attention

Developmental Studies of Attention

One challenge in examining the developmental trajectory of attention is that there is considerable overlap between attention and other neuropsychological constructs, particularly executive functioning (Korkman & Peltomaa, 1991). Because different neuropsychological constructs develop at different rates, assessment tools that are sensitive to differences between executive functioning and attention are critical when examining the development of attention. Traditionally, studies examining the development of attention have used CPT paradigms, as the CPT is considered a standard assessment of sustained attention, response inhibition, and vigilance in school-aged children (Mirsky et al., 1991). Several studies used the NEPSY, a developmental neuropsychological assessment, to examine both attention and executive functioning across childhood (Klenberg, Korman, & Lahti-Nuutilla, 2001; Korkman, Kemp, & Kirk, 2001). While there is considerable variability in the research concerning the developmental trajectory of attention, a general theme is that attention is an evolving neurocognitive process that shows improvements with age throughout childhood.

Luria (1959) was among the first to examine the development of attention in children, and he reported changes in inhibitory control between 3 and a half years and 5 and a half years. Luria found that children around 3 and a half demonstrated the ability to inhibit an inappropriate response, as measured by asking children to press a button when a light appeared. However, when the task was complicated by asking children to press a button in response to a certain colored light, children were unable to consistently inhibit inappropriate responses until around 5 and half years of age.

In 1980, Levy confirmed Luria's findings using the first age normative data for performance on a visual CPT with 230 children ranging in ages from 3 years to 7 years, distributed across 5 age ranges. Results indicated a clear development of the ability to inhibit responses on the CPT between the ages of 4 and 6, with errors of omission and commission declining significantly with age. In regards to auditory sustained attention, Mahone, Pillion, and Hiemenz (2001), used an auditory CPT paradigm with 42 preschoolers and also found steady improvements in children between the ages of 3 and 6 years.

Lin, Hsiao, and Chen (1999) examined sustained attention using a CPT in 341 healthy children between the ages of 6 and 16, and found age-dependent improvements in attention to be most pronounced between the ages of 6 and 12. Rebok et al. (1997) completed a longitudinal study examining sustained attention in 435 children evaluated at ages 8, 10, and 13 years using a CPT paradigm. The researchers measured reaction time, accuracy (correct responses and correct omissions) and omission errors. Results indicated that reaction times improved between 8 and 10 years and then again from 10 to

13 years, while accuracy improved dramatically from 8 to 10 years then had gradual improvement from 10 to 13 years.

Rebok and colleagues (1997) concluded that sustained attention improves rapidly between ages 8 and 10 years then plateaus from 10 to 13 years, with slowed developmental gains during that period. Betts, McKay, Maruff, and Anderson (2006), using the Score! subtest from the TEA-Ch and CogState, a computerized battery of nine neuropsychological subtests, examined sustained attention in children five to twelve years old. Findings were consistent with Rebok et al. (1997), in that children demonstrated improvements in sustained attention until age 10 and then leveled off with only minor improvements.

Welsh, Pennington, and Groisser (1991) used a battery of tests to examine attention and executive functioning in 100 typically developing children between the ages of 3 and 12 years. All children were administered tests of verbal fluency, visual search, motor-finger sequencing, and a three-ring tower task, while children over the age of seven also completed the Wisconsin Card Sorting Test (WCST), a visual matching task, and a more complicated four-ring tower task. Results indicated that children mastered different tasks at different ages, with mastery of the visual search task and three-ring tower task occurring around six years old, and mastery of the more complex visual matching task and WCST occurring around ten years old. Mastery developed last for the verbal fluency task, motor-finger sequencing, and the four-ring tower task.

Levin et al. (1991) reported similar findings to Welsh et al. (1991) on the WCST. Levin et al. administered the WCST to 52 normal children between the ages of seven and

15 and reported major improvements in performance between the 7 to 8 and 9 to 12 year old groups in their ability to shift sets. Both Levin et al. (1991) and Welsh et al. (1991) concluded that attention and executive functioning generally improve with age and support the emergence of pre-frontal skills around the age of six years. These findings support those of Piaget (1954) and other developmental psychologists who report advances in problem-solving and logical thought between the ages of 5 and 7 years.

Several studies have used the NEPSY to examine attention, executive functioning and other neuropsychological skills in school-aged children. Korkman et al. (2001) completed the NEPSY's North American standardization with 800 children aged 5 to 12 years. The auditory attention tasks, tasks of verbal and visual fluency, and a tower task were administered to 8 groups of 100 children divided equally by gender and age. Results indicated significant developmental improvement on all attention and executive functioning tasks between the age groups of 6 and 7 years. Visual attention improved significantly between eight and nine years, and visual fluency improved significantly between nine and ten years. Verbal fluency also showed improvement between eight and nine years and again between 11 and 12 years. Pair wise comparisons were conducted between the attention task scores of 12 year old performance and all other age ranges in order to evaluate the age at which children reach maturity with regards to the attention measures. Results indicated that children reached 12-year-old performance on the auditory and visual attention tasks at 10 years. Visual fluency maturity was reached at 11 years and maturity was not attained for verbal fluency. Maturity was reached on the Tower test by 9 years.

Klenberg and colleagues (2001) examined data collected in the standardization of the Finnish version of the NEPSY. Participants included 400 Finnish children ranging in age from 3 to 12 years who were divided equally by gender into groups of 40 children. Ten subtests measuring inhibition, visual search, planning, auditory and visual attention, and verbal and visual fluency were administered, and results indicated significant age effects on all subtests. Results were quite similar to Korkman et al.'s (2001) study and indicated that development of attention and executive function skills occur at different rates, with motor inhibition maturing around six years old, followed by auditory and visual attention around 10 years and the development of verbal and visual fluency continuing into adolescence. Klenberg et al. (2001) concluded that the neuropsychological constructs of attention and executive functioning have overlapping yet distinct developmental sequences, with basic inhibitory functioning developing before selective attention and more complex executive functions continuing to develop into the teenage years. Klenberg and colleagues (2001) noted that their results were consistent with Barkley's (1997) model of attention and executive functioning, in that inhibition serves as the baseline for the future development of more complex executive functions.

Gender & Attention

The relationship between gender and attention is complex, and studies examining this relationship have yielded varying results. A number of studies have found that gender differences in attention typically favor girls (Bardos, Naglieri, & Prewett, 1992; Klenberg et al., 2001; Pascualvaca et al., 1997). Pascualvaca and colleagues (1997) examined attentional skills in 435 first and second-grade children (mean age of 7.9 years) using three versions of the CPT, the Wisconsin Card Sorting Test (WCST), two digit cancellation tasks, and three subtests of the Wechsler Intelligence Scale for Children-Revised (WISC-R). Results indicated that girls made fewer commission errors on the CPT and earned higher scores on digit cancellation tasks and the Coding subtest of the WISC-R. Boys had faster reaction times on the CPT, suggesting that inhibition is less developed in boys than girls in the early elementary school years. Boys and girls did not differ in their performance on the WCST, suggesting similar abilities in the area of shifting attention.

Bardos and colleagues (1992) examined gender differences in attention in 544 children in grades 2, 6, 10, and combined 4th and 5th grades. Results indicated that girls in the 6th grade and 4th/5th grade samples performed significantly better than boys of the same age on tasks design to assess planning ability, such as a visual search and matching numbers in an array. No gender differences were found on a Stroop task, which assesses selective attention. However, Klenberg and colleagues (2001) found that Finnish girls outperformed Finnish boys on the Auditory Response Set and Visual Attention subtests of the NEPSY, both of which assess selective attention.

In contrast to the findings that girls outperform boys on attention measures, Seidel and Joscho (1990) did not find a significant gender difference in sustained attention on a visual CPT. Lin and colleagues (1999) used a similar CPT paradigm with children between the ages of 6 and 15 and found the boys actually outperformed girls with regard to hit rate and sensitivity, suggesting better sustained attention. However, it is important to point out that Lin et al.'s study consisted of all Taiwanese participants, and sociocultural factors may have contributed to their findings.

Several studies have examined gender differences in ADHD using neuropsychological measures (Newcorn et al., 2001; Rucklidge & Tannock, 2001; Seidman et al., 2005). Newcorn and colleagues (2001) found that boys with ADHD made significantly more impulsivity errors on a CPT than did girls with ADHD. Rucklidge and Tannock found that compared to teenagers without ADHD, girls and boys ages 13 to 16 with ADHD were significantly slower on processing speed measures on the Wechsler Intelligence Scale for Children-Third Edition (WISC-III). However, boys with ADHD were more impaired on processing speed than girls with ADHD. Seidman et al. (2005) examined executive functioning in boys and girls with ADHD ages 9 to 17 and found that there were no significant differences between the boys and girls performance on the attention measures, which included a Stroop test, the WCST, and a CPT.

Parental Education Level & Attention

Socioeconomic status (SES) is a measure of a person or family's economic and social position relative to others, based on a combination of occupation, income, and education (Kraus & Keltner, 2008). It has been well-documented that an individual's level of education is strongly related to occupation and income, with median earnings increasing with each level of education (U.S. Census Bureau, 2004). Higher levels of education are associated with better economic and psychological outcomes, such as greater social support and lower levels of stress (Kraus & Keltner, 2008).

The role of SES and parental education level on child outcome has been extensively researched, and a general finding is that lower SES and less education is associated with more negative psychological, behavioral, and educational outcomes (Campbell, Breaux, Ewing, & Szumowski, 1986; Gingerich, Turnock, Litfin, & Rosen, 1998; Palfrey, Levine, Walker, & Sullivan, 1985; Stevens, 1981). The association between poor attention and low SES has been well documented (Campbell et al., 1986; Palfrey, Levine, Walker, & Sullivan, 1985; Warner-Rogers, Taylor, Taylor, & Sandburg, 2000). However, research suggests that the relationship between low SES and poor attention is complex, as it is not just SES alone but the interaction of SES with other negative life factors which affect the rates of attention problems. For example, low SES has been associated with higher maternal stress, more parental divorce, higher incidence of substance abuse, and poorer medical and psychological treatment compliance, and each of these factors could potentially have a negative impact on a child's attentional abilities (Albee, 1991; Biederman, 1990; Campbell et al., 1986; Gingerich et al.,1998). While it is difficult to control for the myriad of life circumstances associated with SES and parental education level, several studies have examined attentional skills in children from different SES groups and these studies have yielded similar results.

Campbell and colleagues (1986) used parent report and observational measures to evaluate attention in 46 parent-referred 3-year-olds with attention concerns and 22 comparison control children. The children were again evaluated at age 4 and age 6 to determine if the observed hyperactive behaviors persisted with age. Families from the low SES group, as determined by the Hollingshead four factor indexes, had more family disharmony, a less stable job history, more moves, and more psychosocial stress over the course of the three year study. Results of the longitudinal study indicated that lower social class was associated with hyperactivity and aggression at ages 3, 4, and 6, suggesting that these externalizing behaviors first observed in toddlerhood persisted with age. Furthermore, lower social class was also associated with a more troubled mother-child relationship, as measured through observation of free play between the mother and child. Specifically, mothers from the low SES group were more likely to be controlling, negative, and directive in the free play situation. The authors concluded that the specific path to hyperactive behaviors in young children varies, hypothesizing that, "a troubled family climate may contribute to aggression and hyperactivity in some children… through its influence on child-rearing practices and maternal attitudes" (p. 232).

Klenberg et al. (2001), in their Finnish standardization of the NEPSY, found significant interaction effects between performance on certain attention/executive functioning NEPSY subtests and parent's education level (divided into low, medium, and high education levels). Specifically, children who had parents with medium or high education levels had stronger performances on the Semantic Fluency, Phonemic Fluency, and Visual Search subtests than children with parents in the low education level group. However, there was no interaction between parent education level and early maturing tasks of inhibition. The authors concluded that parent education level was more strongly reflected on tasks of executive functioning than tasks predominantly measuring attention or inhibition. The authors hypothesize that, "The development of fluency… is more strongly connected to environmental factors and learning, whereas, in the earlier maturing functions of inhibition and attention, the development may depend more strongly on neural maturation" (p. 424).

D'Angiulli, Herdman, Stapells, and Hertzman (2008) investigated the relationship between SES and auditory selective attention by comparing event-related potentials (ERPs) in 28 lower- and higher-SES children between the ages of 11 and 14. All children completed an auditory task in which they were instructed to attend to two types of tones while ignoring two other types. Results found that ERP waveform differences between the attended and unattended tones were significant in the higher SES group but not in the lower SES group. This finding suggests the lower SES group allocated roughly equal attentional resources to both the relevant and irrelevant auditory stimuli, while the higher SES group selectively attended to only the relevant information. However, there was no significant difference in accuracy or reaction times between the two groups. The authors hypothesized that in order for the lower SES group to perform at the same level as the higher SES group, they may have allocated additional resources to attend to both the relevant and the irrelevant stimuli. In other words, the lower SES group had to exert more mental effort on the task to perform like the higher SES group.

Ethnicity & Attention

There is limited research on the relationship between ethnicity and attentional skills in children. The majority of the research in this area examines the relationship between ethnic minorities and attentional problems including both hyperactivity and inattention. Research indicates that African American children are more likely to be diagnosed with attention problems and Hispanic children are less likely to be identified as having attention problems than their Caucasian peers (Gingerich et al., 1998). However, the demographics of ADHD are evolving, with Hispanic school-age children having the highest increased rate of first-time ADHD diagnosis between the years 2003 and 2007 (Visser et al., 2010).

Researchers report several problems with the relationship between minority children and attention deficits. First, very few studies using standardized assessment tools have investigated attentional differences between minority children and Caucasian children without attention deficits, so it remains largely unknown if any differences between specific attentional skills even exist. Second, the majority of the research about the increased rates of poor attention and hyperactivity in minority students relies upon behavioral rating forms completed by teachers (Evans et al., 2010). This is problematic given the subjectivity and response bias related to behavioral rating forms. Stevens (1981) investigated whether or not a child's ethnicity and social status influenced behavioral ratings of hyperactivity by school psychologists, parents, and teachers. Raters, all of middle SES, watched videos of Caucasian, Mexican American, and African American boys, and read vignettes about the boys which were systematically varied to include information about whether the boys were of middle or low SES. Results indicated that school psychologists rated the low SES boys as more hyperactive, and of the low SES boys, school psychologists rated the Mexican American and African American boys as more hyperactive than the Caucasian boys. Teachers' ratings were less biased than those of the school psychologists, with the exception of rating Mexican American boys as less hyperactive than African American and Caucasian boys. Parents' ratings indicated higher hyperactivity ratings for the African American boys than the Caucasian or Mexican American boys. Clearly, diagnostic bias and cultural insensitivity can lead to misdiagnosis of hyperactivity or inattention in children from diverse ethnic groups. Additional research using standardized assessment tools is needed to investigate the nature of the relationship between ethnicity and attention.

To date, only a few published studies have examined the relationship between specific attentional skills and ethnicity including typically functioning Hispanic and African American children as participants. Byrd, Arentoft, Scheiner, Westerveld, and Baron (2008) completed a review of the empirical literature on the current state of multicultural neuropsychological assessment in children. By searching the PubMed and PsycINFO databases, as well as the table of contents of Developmental Neuropsychology and Child Neuropsychology from 2003-2008, the authors reviewed 1,834 article abstracts and identified only ten papers that met inclusion criteria. Of the ten articles, only one specifically investigated attention differences between ethnic groups in the United States.

Mezzacappa (2004) administered a computerized test of executive attention, the Attention Network Test (ANT) to a diverse group of 249 Caucasian, Hispanic, and African American children between the ages of 4 and 7 from various SES groups to examine the relationship between attention and sociodemographics. The authors hypothesized that older children and children of higher SES would perform better than younger children from lower SES groups, and race/ethnicity was not hypothesized to impact performance when separated from SES. While older children did perform better than younger children, as expected, the hypotheses about SES and race/ethnicity were not supported. Specifically, African American and Hispanic children were less distracted by interference than were Caucasian children, above and beyond any effects of SES, gender, and age. Also, Hispanic children had the most proficient reaction time on the task, even though as a group the Hispanic children were heavily overrepresented in the lowest SES stratum and underrepresented in the highest SES stratum. The strong performance of Hispanic children as a group contrasts sharply with the authors predictions about SES and task performance. The authors hypothesized that one reason the Hispanic children outperformed the Caucasian and African American children is exposure to two languages. Of the Hispanic participants, 69% spoke mostly or only Spanish at home, and the authors hypothesized that, "Some Hispanic children in this study were more adept at resolving the interference of competing demands by virtue of their ongoing exposure to two languages" (p.1384).

Roselli, Ardila, Bateman, and Guzman (2001) examined neuropsychological functioning in Spanish-speaking children in Columbia and compared the results to neuropsychological test norms of American children. Participants included 292 healthy children between the ages of 6 and 11. The following neuropsychological tests were administered: Seashore Rhythm Test, Finger Tapping Test, (FTT) Grooved Pegboard Test, Children's Category Test, California Verbal Learning Test-Children's Version (CVLT-C), Benton Visual Retention Test, and Bateria Woodcock Psicoeducativa en Espanol (Spanish version of the Woodcock-Johnson Psycho-Educational Battery). Results indicated that the Columbian children performed better than American children on the Seashore Rhythm Test and on the CVLT-C, as well as on the FTT. On the FTT, American children had a much slower increase of taps with both the preferred and nonpreferred hands than the Columbian children. Although attentional skills were not specifically investigated in this study, there were no significant differences on the Spanish versions of the intelligence and academic achievement tests between Columbian and American children. This study is important as it is among the first to comprehensively examine neuropsychological functioning in Spanish-speaking children using measures normed on American children.

Levav, Mirsky, French, and Bartko (1998) examined neuropsychological functioning in healthy children and adults from five countries ranging in age from 8 to 90. Participants were from Canada, Israel, Ireland, Ecuador, and the United States. The researchers were more interested in examining cultural rather than ethnic differences in neuropsychological functioning and ethnicity of participants was not reported; thus, the racial breakdown of participants is unclear. However, all tests in Ecuador were administered in Spanish. Neuropsychological measures included visual and auditory CPT paradigms, the Stroop test, the Wisconsin Card Sorting Test (WCST), Trail Making tests, and Digit Span tests. Results revealed very high consistency across countries and age on measures of sustained attention and reaction time. Subtle differences were observed on measures of focused attention, response inhibition, problem solving, and cognitive flexibility. The authors concluded that despite the small discrepancies in performance, their results suggest that most neurocognitive skills are robust to cultural differences.

Statement of the Problem

A review of the literature reveals that while there is ample research surrounding certain aspects of attention, there are many aspects of attention that are significantly underrepresented in the current literature. First, the majority of attention research examines children with ADHD, resulting in relatively few studies examining attentional functioning in children without ADHD or other attentional problems. The body of attentional research would be strengthened by examining not just children with abnormal attentional functioning but also normal attention. Second, children from diverse ethnic and socioeconomic backgrounds are significantly underrepresented in the current research, as the majority of the research examines attention in Caucasian middle-class children. Third, the majority of attention research relies upon behavior rating scales to measure attention, with relatively fewer studies using standardized performance measures to evaluate attentional functioning in children. Furthermore, the research that uses performance measures tends to measure only one aspect of attention (i.e. sustained attention with a CPT). Few studies examine the multidimensional aspects of attention, although there is strong support in the neuropsychological literature that attention is a multidimensional construct (Mirsky et al., 1991). The TEA-Ch is a unique and valuable assessment tool because it provides a standardized measurement of multiple aspects of attention (i.e. sustained, selective, and shifting). By providing a more detailed picture of a child's specific attentional strengths and weaknesses, the TEA-Ch results can help to aid in the development of targeted interventions.

The current study was done in an attempt to add to the research base regarding demographic and developmental differences in attention in school-age children. The aim was to examine whether the factors of gender, ethnicity, and parental level of education contribute significantly to differences in attentional skills across participants using the TEA-Ch to provide a standardized, multidimensional measurement of attention. It was hypothesized that demographic variables would account for a significant amount of the variance in attention scores on the TEA-Ch. Specific hypotheses are presented below.

Hypotheses

1) It was hypothesized that girls would score higher than boys on sustained attention subtests and on selective attention subtests.
2) It was hypothesized that there would be no significant difference between girls' scores and boys' scores on shifting attention subtests.
3) It was hypothesized that as parental education level increases, scores on each of the nine subtests would improve.
4) It was hypothesized that ethnicity (i.e. Caucasian, African American, and Hispanic) would not be predictive of any of the nine subtest scores.

CHAPTER III

METHODOLOGY

The purpose of this study was to examine if demographic variables are predictive of the nine subtest scores on the Test of Everyday Attention for Children (TEA-Ch). The TEA-Ch measures the areas of sustained, selective, and shifting attention. The demographic variables of interest included in the study were gender, ethnicity, and parent's education level.

Participants

Participants in this study were recruited from various locations across the United States, with the majority residing in the North Texas area. Participants were selected to match specified age, gender, ethnicity, and parent's education levels to approximate the 2005 U.S. Census data. The age range for the children in the study was from 6 years, 0 months to 15 years, 11 months. The participants were divided into five age groups, namely 6.0-6.11 years, 7.0-8.11 years, 9.0-10.11 years, 11.0-12.11 years, and 13.0-15.11 years. Participants were further identified based on ethnicity (Caucasian, African American, or Hispanic) and parent's education level (less than a high school degree, completed high school, completed two or more years of college or a trade school, completed four years of college, or completed a graduate degree). Potential participants who reported having a learning disability, identified attention problems, a serious head injury (resulting in loss of consciousness) or a serious neurological illness (such as cerebral palsy or epilepsy) were excluded from the present study. Also, children who had been evaluated for special education services or who had serious sensory loss (i.e. hearing or vision) were excluded from the present study. It was anticipated that approximately 240 children would be administered the TEA-Ch and results analyzed for the present study. However, at the end of the study, the sample included 158 children. While the sample was smaller than initially intended, power analyses revealed that effect sizes with 158 participants typically run at a moderate level.

Procedures

Approval for the current research study was obtained from the Texas Woman's University Institutional Review Board (IRB) and written parent consent was obtained from the parents or guardians of the children prior to the evaluation and child assent was also obtained. Prior to administration of the TEA-Ch, a participant recruitment script, which consisted of eight questions the examiner asks of parents, was completed to determine if the potential child matched a targeted child in the sample. If the child qualified for the study, he or she was assigned a case number based on his or her demographic data. The TEA-Ch tests were administered by graduate and undergraduate students formally trained on the administration of the TEA-Ch. Examiners were instructed to administer Version A of the TEA-Ch. Each administration took approximately one hour, with brief opportunities for the children to rest between tasks as the examiner prepared for the next subtest. Administration was standardized and took place in a quiet setting agreed upon by the examiner and parent.

Following completion of the TEA-Ch administration, examiners scored the tests and provided parents a brief summary sheet of their child's TEA-Ch results. Every TEA-Ch protocol was double-checked for scoring accuracy by one of the principal researchers. Demographic data and subtest scores, including raw scores and scaled scores, from each protocol was coded and entered into a computer database by graduate students formally trained in data collection and assessment.

Measures

The Test of Everyday Attention for Children (TEA-Ch)

The TEA-Ch is described in the manual as a "standardized and normed clinical battery for children that allows for relative assessment *across* different attentional capacities" (Manly et al., 1999, p. 5). The manual further suggests that the TEA-Ch is unique among measures of attention in that it minimizes the need for other neuropsychological skills such as language and memory, providing a more straightforward measure of a child's attentional skills. The TEA-Ch is comprised of nine subtests designed to measure three different factors of attention, selective, sustained, and shifting, in children and adolescents ages 6 years to 15 years, 11 months. There are two parallel forms of the test (Version A and Version B) that allow for retesting the same child. The first four subtests in the battery can be used as a brief screener to provide an estimate of each of the attentional factors. The entire battery of nine subtests was examined for the purpose of this study.

Manly et al. (1999) states that the TEA-Ch was normed on 293 Australian children and adolescents between the ages of 6 and 16 years and stratified into six age bands. Children were excluded from the normative sample if they met any of the following criteria: head injury or neurological illness, developmental delay or sensory loss, referral for attention or learning problems, assessed as having special education needs. Version A of the TEA-Ch was administered to all 293 of the children in the sample. Fifty-five children were re-administered the TEA-Ch between 6 and 15 days after the initial administration to establish retest reliability. In terms of reliability of the TEA-Ch, test-retest correlation coefficients with age partialed out ranged from .85 for Opposite World time to .57 for Creature Counting timing score. The majority of subtest reliability fell in the .70 to .80 range, indicating satisfactory reliability. The TEA-Ch is sensitive to differences between children with ADHD and healthy controls (Anderson et al., 1998), and is also sensitive to differences between children with Traumatic Brain Injuries and healthy controls (Manly et al., 2001; Sutcliffe et al., 2006).

The TEA-Ch was developed, in large part, to measure how a child's performance differs based on the aspect of attention being assessed (i.e. sustained, selective, or shifting attention). In order to examine the relationship between scores on the TEA-Ch and the three attention factors, structural equation modeling was used. The authors of the TEA-Ch presented a structural equation model of performance on the TEA-Ch to provide support for its validity, with the three-factor model yielding a close fit to the data demonstrated by a non-significant x^2 statistic (Manly et al., 1999). The validity of the TEA-Ch for use with Australian and Chinese children has been well-demonstrated (Chan et al., 2008; Manly et al., 2001). A cross-validation study of the TEA-Ch for use with children in the United States is currently being completed examining the structure of the

TEA-Ch using structural equation modeling and factor analysis with the current sample. The TEA-Ch manual provides the following descriptions of the nine subtests and three attention factors (Manly et al., 1999).

Selective attention subtests. Selective attention refers to a child's ability to select target information from distracters. The child must determine which elements are important and attend to those elements while ignoring irrelevant information. TEA-Ch subtests that measure selective attention include Sky Search and Map Mission. The Sky Search subtest is described as a brief, timed subtest that consists of two parts. In the first part, children have to find as many target spaceships as possible on a sheet filled with very similar distracter spaceships. In the second part, the distracter spaceships are removed so children simply circle the target spaceships as quickly as possible. Subtracting the child's score in part two from his or her score in part one provides a selective attention score that is relatively free from the influence of slow motor skills. The Map Mission subtest requires the child to visually scan a map to find as many target symbols (i.e. knife & fork) as he or she can in one minute.

Sustained attention subtests. Sustained attention involves maintaining attention to a task over a long period of time, even if the task does very little to hold the child's attention. Subtests that measure sustained attention include Score!, Walk, Don't Walk, Code Transmission, Score DT, and Sky Search DT. Score! requires children to count the number of 'scoring' sounds they hear on a CD, and announce the total number of sounds at the end of each trial. Due to the simplicity of this task, as well as the long gaps between some of the sounds, this is a good measure of a child's ability to self-sustain his or her own attention. On the Walk, Don't Walk subtest, children are given a sheet showing footprints on a path. They are asked to take one step, using a marker, along the path each time a tone sounds. When a tone unpredictably ends differently from the rest, they are expected to stop where they are on the path. This task requires children to inhibit their automatic response to the tone and maintain attention to the task.

Code Transmission requires children to listen to a monotonous series of spoken numbers in order to hear two fives in a row. Each time they hear two fives in a row, they have to say the number that came immediately before the two fives. The length of time between double fives builds over the course of the 12 minute test, and the tediousness of the task increases the demands on the child's ability to self-sustain attention. Score DT asks children to complete two tasks at the same time: count the number of scoring sounds they hear in a given trial (similar to the task in Score!) and listen to audio news broadcast and identify the animal mentioned in the broadcast. After each trial, children are asked to repeat the number of scoring sounds and the animal in the broadcast. Children are advised in the instructions to devote most of their attention to the score counting, as attending to the words of the news broadcast is relatively easy. This task measures a child's capacity to strategically allocate attention over time. Sky Search DT requires children to complete a parallel version of the Sky Search task (circling target spaceships as quickly as possible) while at the same time counting the number of score sounds (as they did in the Score! subtest) and announcing the number of score sounds at the end of each trial.

Shifting attention subtests. Shifting attention is the final factor measured by the TEA-Ch. Shifting attention refers to the ability to change the focus of attention smoothly and adaptively between one thing and another. Subtests measuring shifting attention include Creature Counting and Opposite Worlds. Creature Counting requires children to count creatures from top to bottom and use up and down arrows as cues to switch the direction in which they are counting. Accuracy and time are recorded in this task. In the Same World children simply name digits as they see them (1 or 2) along a path as quickly as possible. In the Opposite World, children do the same task except that when they see a two they must say 'one' and when they see a one they must say 'two'. Children move on to the next number on the path only after the correct response is given. Time taken to complete the task is recorded for the score of the subtest.

Data Analysis

Data from the variables of interest were examined using the Statistical Package for the Social Sciences version 15.0 (SPSS). The normality of all continous measures was tested using Shapiro-Wilk test of normality and skewness and kurtosis statistics. Due to issues of non-normality, the decision was made to conduct both parametric and non-parametric tests where possible. Frequencies and percentages were used to describe the demographic characteristics of the sample and means and standard deviations were used to describe the continuous subscale scores. Relationships among demographics were tested using crosstabulations with Pearson's chi square. Spearman's correlations were used to examine the nature of the relationships between subtest scores. The results were analyzed to determine the degree of the relationship between each subtest scores and each of the demographic variables, as well as the significance of direction of the relationships. The hypotheses were each tested using nonparametric Kruskal-Wallis and/or Mann Whitney U tests with TEA-Ch subtests as the dependent variables.

Hypothesis #1 and Hypothesis #2 were analyzed comparing males and females on the TEA-Ch subtests means. Hypothesis #3 was analyzed with the independent variable being categorical parental education level. Hypothesis #4 was analyzed with the independent variable being categorical ethnicity. In regards to Hypothesis #4, simple linear regressions were also conducted to identify if ethnicity was predictive of TEA-Ch scores by examining the amount of variance in test scores accounted for by ethnicity. Furthermore, after determining which demographic variables were significant in the preliminary analyses described above, additional analyses included a series of multiple linear regressions to examine the amount of variance accounted for by the variables of interest in predicting each of the nine subtest scores.

CHAPTER IV

RESULTS

Introduction

Prior to any analysis, the data was checked for outliers. Outliers were found in the Sky Search ($n = 1$), Map Mission ($n = 5$), and Sky Search DT subtests ($n = 4$). All analyses were conducted both with the outliers included and with the outliers removed. Due to a small difference in findings (i.e. p values moving from greater than .05 to less than .05 and vice versa) the decision was made to report the analyses with outlier points removed.

The normality of all continuous variables was evaluated by examining the Shapiro-Wilk test of normality, skewness and kurtosis statistics, and the distribution histograms. Although all continuous variables had very good skewness statistics (± .5), good kurtosis statistics (± 1.0), and histograms with a relatively normal shape, only the Score DT and Code Transmission subtests definitively passed the Shapiro-Wilk test of normality ($p > .05$). In addition, Sky Search, Map Mission, Score!, and Opposite World had Shapiro-Wilk significance levels of $p > .001$, which is generally considered robust enough for parametric statistics (Norman, 2001). With Shapiro-Wilk p-values $< .001$, the Walk Don't Run, Sky Search DT, and Creature Counting subtests required confirmation with nonparametric statistics. Due to the fact that some subtests needed nonparametric confirmation, hypothesis testing was conducted primarily with nonparametric statistics. All significance is discussed at the $p < .05$ significance level.

Sample Description

The total number of children represented in the current sample is 158. As shown in Table 1, approximately half of the participants were male (49.4%) and half female (50.6%). Caucasian children made up almost 70% of the sample (69.6%), African American children represented 18.4% of the sample, and Hispanic children made up 12.0% of the sample. Nearly 60% of the sample had parents with more than a high school diploma (59.5%), 25.3% had parents with a high school diploma, and 15.2% had parents with less than a high school diploma. For age, the groups with the highest percentage of participants were 7 to 8.11 years (25.3%) and 9 to 10.11 years (23.4%) groups. The groups with the lowest percentage of participants were in the 13 to 14.11 year group (12.0%) and the 15 to 15.11 year old group (5.1%). For further analyses, the 13 to 14.11 year group and the 15 to 15.11 year group were combined to form one group made up of participants from 13-15.11 years old. Also, to test the relationships among demographic variables in testing the predictive relationships, age was analyzed as a continuous variable. The range of the continuous was one (6 years old) to six (15 years old), with a mean of 3.03 (*SD* = 1.41).

As shown in Table 2, crosstabulations with Pearson's Chi Square showed no significant relationships between gender and the other demographic variables of ethnicity and parent education. As shown in Table 3, there was a significant relationship between ethnicity and parent education, χ^2 (4) = 15.10, $p < .01$, Cramer's $V = .219$. A greater proportion of Caucasians had greater than a high school diploma (62.7%) compared to African-Americans (55.2%) or Hispanics (47.4%). A smaller proportion of Hispanics had a high school diploma (10.5%) compared to Caucasians (28.2%) or African-Americans (24.1%). Also, a smaller proportion of Caucasians (9.1%) had less than a high school diploma compared to African-Americans (20.7%) or Hispanics (42.1%). As previously stated, the relationship between gender and parent education was not significant.

Table 1

Frequencies and Percentages for Categorical Demographic Variables

	Frequency	%
Gender		
Male	78	49.4
Female	80	50.6
Ethnicity		
Caucasian	110	69.6
African American	29	18.4
Hispanic	19	12.0
Parent Education		
Less than High School	24	15.2
High School	40	25.3
Greater than High School	94	59.5
Age		
6-6.11 Years	24	15.2
7-8.11 Years	40	25.3
9-10.11 Years	37	23.4
11-12.11 Years	30	19.0
13-14.11 Years	19	12.0
15-15.11 Years	8	5.1

Table 2

Frequencies and Percentages for Ethnicity and Parent Education by Gender

	Male		Female			
	n	%	n	%	χ^2	*P*
Ethnicity					.80	.672
Caucasian	54	69.2	56	70.0		
African American	13	16.7	16	20.0		
Hispanic	11	14.1	8	10.0		
Parent Education					1.08	.582
Less than High School	13	16.7	11	13.8		
High School	17	21.8	23	28.8		
Greater than High School	48	61.5	46	57.5		

As shown in Table 4, and as mentioned previously, there was a significant relationship between parent education and ethnicity. When described by education level, a greater proportion of those with a high school education (77.5%) or greater than a high school education (73.4%) were Caucasian compared to those with less than a high school education (41.7%). A greater proportion of those with less than a high school education were African American (25.0%) compared to those with a high school education (17.5%) or greater than a high school education (17.0%). Finally, a greater proportion of those with less than a high school education were Hispanic (33.3%) compared to those with a high school education (5.0%) or greater than a high school education (9.6%). There was not a significant relationship between parent education and gender.

Table 3

Frequencies and Percentages for Gender and Parent Education by Ethnicity

	Caucasian		African American		Hispanic			
	n	%	N	%	n	%	χ^2	*p*
Gender							.80	.672
Male	54	49.1	13	44.8	11	57.9		
Female	56	50.9	16	55.2	8	42.1		
							15.10	.004
Parent Education								
Less than High School	10	9.1	6	20.7	8	42.1		
High School	31	28.2	7	24.1	2	10.5		
Greater than High School	69	62.7	16	55.2	9	47.4		

Table 4

Frequencies and Percentages for Gender and Ethnicity by Parent Education

	Less Than High School		High School		Greater Than High School			
	n	%	n	%	N	%	χ^2	*p*
Gender							1.08	.582
Male	13	54.2	17	42.5	48	51.1		
Female	11	45.8	23	57.5	46	48.9		
Ethnicity							15.10	.004
Caucasian	10	41.7	31	77.5	69	73.4		
African American	6	25.0	7	17.5	16	17.0		
Hispanic	8	33.3	2	5.0	9	9.6		

As shown in Table 5, there was no significant difference between the age of males and females. In addition, as shown in Table 6, there was no significant relationship between age and ethnicity or between age and education level.

Table 5

Means and Standard Deviations for Age by Gender

	n	Mean	*SD*	*T*	*p*
Age				-.33	.739
Male	78	2.99	1.36		
Female	80	3.06	1.47		

Table 6

Means and Standard Deviations for Age by Ethnicity and by Parent Education

	n	Mean	*SD*	*F*	*p*
Ethnicity				.66	.519
Caucasian	110	2.95	1.37		
African American	29	3.28	1.58		
Hispanic	19	3.11	1.41		
Parent Education				.45	.639
Less Than High School	24	3.04	1.33		
High School	40	3.20	1.44		
Greater Than High School	94	2.95	1.43		

Test of Everyday Attention for Children (TEA-Ch)

The dependent variables are grouped according to the theoretical attentional construct being measured, see Table 7. The first was Selective Attention, which was \ "5a cx/9.62, *SD* = 2.56). The second was Sustained Attention, which was made up of the subtests of Score! (*M* = 10.47, *SD* = 3.38), Score DT (*M* = 10.54, *SD* = 3.32), Walk, Don't Walk (*M* = 10.91, *SD* = 4.47), Code Transmission (*M* = 9.68, *SD* = 3.31), and Sky Search DT (*M* = 7.99, *SD* = 3.30). The third was Shifting Attention, which was made up of the subtests of Creature Counting (*M* = 10.51, *SD* = 3.18) and Opposite Worlds (*M* = 8.62, *SD* = 3.28).

Table 7

Means and Standard Deviations for Test of Everyday Attention Subtests

	N	Mean	*SD*	Min	Max
Selective Attention					
Sky Search	157	10.10	2.71	2	17
Map Mission	153	9.62	2.56	4	15
Sustained Attention					
Score!	158	10.47	3.38	3	18
Score DT	158	10.54	3.32	2	19
Walk, Don't Walk	158	10.91	4.47	1	19
Code Transmission	158	9.68	3.31	1	18
Sky Search DT	154	7.99	3.30	1	16
Shifting Attention					
Creature Counting	158	10.51	3.18	2	17
Opposite Worlds	158	8.62	3.28	1	15

The relationships among the nine subtests are shown in Table 8 using nonparametric Spearman's correlation coefficients. All of the significant correlations were in the positive direction, indicating that higher scores on these subtests were associated with higher scores on the correlated subtest. For the relationships between the Selective Attention subtest and the other dependent variables, there was a significant positive correlation between Sky Search and the Map Mission ($r = .327, p < .001$), Score DT ($r = .166, p < .05$), Code Transmission ($r = .158, p < .05$) and Opposites World ($r = .212, p < .01$) subtests. Map Mission was significantly and positively correlated with Score DT ($r = .226, p < .01$), Code Transmission ($r = .220, p < .01$), and Opposites World ($r = .306, p < .001$). The relationships between the Sustained Attention subtests and the other dependent variables show significant and positive relationships between Score! with Score DT ($r = .381, p < .001$), Walk ($r = .177, p < .05$), Code Transmission ($r = .337, p < .001$), and Opposites World ($r = .275, p < .001$). The relationships between Score DT and Code Transmission ($r = .490, p < .001$), Sky Search DT ($r = .235, p < .01$), Creature Counting ($r = .167, p < .05$), and Opposite Worlds ($r = .384, p < .001$) were significantly and positively correlated. In addition, a significant and positive correlation was found between Code Transmission with Sky Search DT ($r = .228, p < .01$) and Opposite Worlds ($r = .290, p < .001$). Finally, a significant and positive correlation was found between Sky Search DT with Creature Counting ($r = .186, p < .05$) and Opposite Worlds ($r = .231, p < .01$).

Table 8

Spearman's Correlation Coefficients Among Test of Everyday Attention Subtests

	1	2	3	4	5	6	7	8
1. Sky Search								
2. Map Mission	.327 ***							
3. Score!	-.013	.147						
4. Score DT	.166 *	.226 **	.381 ***					
5. Walk, Don't Walk	.030	-.022	.177 *	.147				
6. Code Transmission	.158 *	.220 **	.337 ***	.490 ***	.139			
7. Sky Search DT	.018	.100	.137	.235 **	.052	.228 **		
8. Creature Counting	.132	.144	.062	.167 *	.015	.119	.186 **	
9. Opposite Worlds	.212 **	.306 ***	.275 ***	.384 ***	.111	.290 ***	.231 **	.114

Note. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Primary Analyses

Due to the non-normal distribution of some of the subtests, both parametric multivariate analysis of variance (MANOVA) and nonparametric comparisons were used to test the first three hypotheses. However, only the nonparametric Mann-Whitney U and Kruskal-Wallis tests are reported as the majority of subtests violated the Shapiro-Wilk test of normality. Hypothesis four was tested using both nonparametric tests and a series of simple linear regressions. Additional analyses were also conducted using a series of multiple linear regressions in order to examine the effects of each demographic characteristic, while controlling for the effect of the other demographics.

Hypothesis One: It was Hypothesized that Girls would Score Higher than Boys on Sustained Attention Subtests and on Selective Attention Subtests

When the five subtests that measure sustained attention were tested using nonparametric Mann-Whitney U tests, differences between males and females were not found ($p > .05$), see Table 9. Differences between the Selective Attention subtests of Sky Search and Map Mission were also tested using nonparametric Mann-Whitney U tests. Females (Median = 10.00) scored significantly higher than males (Median = 9.00) on the Map Mission subtest, $Z = 3.21, p < .01$. No differences were found on the Sky Search subtest ($p > .05$).

Table 9

Means and Standard Deviations for Test of Everyday Attention Subtests by Gender

	N	Mean	*SD*	Median	*Z*	*p*
			Selective Attention			
Sky Search					.69	.488
Male	74	10.35	2.89	10.00		
Female	74	9.81	2.44	10.00		
Map Mission					3.21	.001
Male	74	9.00	2.48	9.00		
Female	74	10.20	2.53	10.00		
			Sustained Attention			
Score!					1.42	.157
Male	74	9.95	3.48	10.00		
Female	74	10.70	3.20	11.00		
Score DT					1.66	.098
Male	74	10.00	3.46	10.00		
Female	74	10.86	3.13	11.00		
Walk, Don't Walk					.42	.674
Male	74	10.80	4.70	10.00		
Female	74	10.88	4.40	11.00		
Code Transmission					.77	.439
Male	74	9.30	3.55	10.00		
Female	74	10.04	3.14	10.00		
Sky Search DT					.76	.449
Male	74	7.91	3.58	8.00		
Female	74	8.15	2.93	9.00		

Hypothesis Two: It was Hypothesized that there would be No Significant Difference between Girls' Scores and Boys' Scores on Shifting Attention Subtests

The two subtests that measure shifting attention were also tested for differences between males and females using nonparametric Mann-Whitney U tests, see Table 10. For the Creature Counting subtest, females (Median = 11.00) scored significantly higher than males (10.00), $Z = 2.12, p < .05$. No significant differences were found between males and females for the Opposite Worlds subtest ($p < .05$).

Table 10

Means and Standard Deviations for Shifting Attention Subtests by Gender

	Shifting Attention					
	N	Mean	*SD*	Median	*Z*	*p*
Creature Counting					2.12	.034
Male	74	10.28	2.99	10.00		
Female	74	10.92	3.10	11.00		
Opposite Worlds					1.35	.178
Male	74	8.19	3.02	8.50		
Female	74	8.99	3.46	9.00		

Hypothesis Three: It was Hypothesized that as Parental Education Level Increases, Scores on each of the Nine Subtests would Improve

A series of Kruskal-Wallis nonparametric tests were used to test for differences between parent education levels for each of the nine TEA-Ch subtests. As shown in

Table 11, no significant differences were found between children with parents who did not have a high school diploma, had a high school diploma, or had more education than a high school diploma ($p > .05$).

Table 11

Means and Standard Deviations for Test of Everyday Attention Subtests by Parent Education

	n	Mean	*SD*	Median	$\chi 2$	*p*
Sky Search					.79	.673
Less than High School	21	10.67	2.78	11.00		
High School	37	9.76	2.63	10.00		
Greater than High School	90	10.08	2.68	10.00		
Map Mission					5.00	.082
Less than High School	21	9.19	3.01	9.00		
High School	37	10.49	2.70	10.00		
Greater than High School	90	9.33	2.34	9.00		
Score!					2.54	.281
Less than High School	21	9.29	2.80	10.00		
High School	37	10.32	3.88	11.00		
Greater than High School	90	10.57	3.22	11.00		
Score DT					5.93	.052
Less than High School	21	8.90	3.00	9.00		
High School	37	10.95	4.20	11.50		
Greater than High School	90	10.58	2.90	11.00		
Walk, Don't Walk					.09	.955
Less than High School	21	11.62	4.59	9.50		
High School	37	10.51	5.40	11.00		
Greater than High School	90	10.79	4.16	10.00		

(Table 11, continued)

Table 11, continued

	n	Mean	SD	Median	$\chi 2$	p
Code Transmission					2.72	.256
Less than High School	21	8.43	3.43	8.50		
High School	37	9.70	3.73	9.50		
Greater than High School	90	9.94	3.15	10.00		
Sky Search DT					.03	.986
Less than High School	21	8.00	3.46	8.00		
High School	37	8.16	2.96	8.00		
Greater than High School	90	7.98	3.37	8.00		
Creature Counting					3.94	.140
Less than High School	21	9.19	3.39	9.50		
High School	37	10.76	3.00	11.00		
Greater than High School	90	10.87	2.93	11.00		
Opposite Worlds					.77	.679
Less than High School	21	7.62	3.58	8.50		
High School	37	8.86	3.42	8.50		
Greater than High School	90	8.70	3.11	9.00		

Hypothesis Four: It was Hypothesized that Ethnicity (i.e. Caucasian, African American, and Hispanic) would not be Predictive of any of the Nine Subtest Scores

A series of Kruskal-Wallis nonparametric tests were used to test for differences between ethnic groups for each of the nine TEA-Ch subtests. As shown in Table 12, a significant relationship was found between ethnicity and the Score! subtest, χ^2 (2) = 11.59, $p = .003$. Mann-Whitney U analyses revealed that Caucasian children (Median = 11.00) scored significantly higher than Hispanic children (Median = 8.00), $p < .05$. The Score DT subtest was also significantly related to ethnicity, χ^2 (2) = 6.64, $p = .036$.

Mann-Whitney U tests revealed that Caucasian (Median = 11.00) children had significantly higher scores than Hispanic children (Median = 9.00) on the Score DT subtest. Finally, a significant relationship was found between the Code Transmission subtest and ethnicity, χ^2 (2) = 7.31, p = .026 using a Kruskal-Wallis test. Mann Whitney U nonparametric analyses revealed that Caucasian children (Median = 10.00) scored significantly higher than African-American children (Median = 9.00), $p < .05$.

Table 12

Means and Standard Deviations for Test of Everyday Attention Subtests by Ethnicity

	n	Mean	SD	Median	χ^2	p
Sky Search					.83	.660
Caucasian	104	9.91	2.63	10.00		
African American	25	10.32	3.02	10.00		
Hispanic	19	10.68	2.47	10.00		
Map Mission					1.43	.488
Caucasian	104	9.81	2.62	9.00		
African American	25	8.88	2.42	9.00		
Hispanic	19	9.42	2.39	10.00		
Score!					11.59	.003
Caucasian	104	10.87	3.42	11.00 [a]		
African American	25	9.48	3.02	10.00 [ab]		
Hispanic	19	8.47	2.48	8.00 [b]		

(Table 12, continued)

Table 12, continued

	n	Mean	SD	Median	$\chi2$	p
Score DT					6.64	.036
Caucasian	104	10.88	3.27	11.00 [a]		
African American	25	9.68	3.17	9.00 [ab]		
Hispanic	19	9.00	3.37	9.00 [b]		
Walk, Don't Walk					1.84	.399
Caucasian	104	10.59	4.35	10.00		
African American	25	11.60	5.21	12.00		
Hispanic	19	11.21	4.71	10.00		
Code Transmission					7.31	.026
Caucasian	104	10.09	3.21	10.00 [a]		
African American	25	8.16	2.91	9.00 [b]		
Hispanic	19	9.37	4.21	9.00 [ab]		
Sky Search DT					1.75	.417
Caucasian	104	8.25	3.23	9.00		
African American	25	7.76	3.49	8.00		
Hispanic	19	7.16	3.10	8.00		
Creature Counting					4.22	.121
Caucasian	104	10.79	3.02	11.00		
African American	25	10.96	2.67	11.00		
Hispanic	19	9.11	3.40	9.00		
Opposite Worlds					2.58	.275
Caucasian	104	8.85	3.17	9.00		
African American	25	8.28	3.13	8.00		
Hispanic	19	7.58	3.82	8.00		

Note. Median scores with different superscripts differ significantly using Mann-Whitney U test ($p < .05$)

In addition, simple linear regressions predicting each of the nine subtest scores from the ethnic groups were conducted to test for predictive relationships and in order to obtain the variance accounted for by ethnicity for any subtest significantly predicted by ethnicity, see Table 13. The overall model predicting the Score! subtest was significant, $F\,(2, 155) = 5.61, p < .05, R^2 = .067$. Being Caucasian predicted higher scores on Score! compared to being Hispanic (*Beta* = -.244, $p < .01$). Similarly, the overall model predicting the Score DT subtest was significant, $F\,(2, 155) = 3.45, p < .05, R^2 = .043$. Being Caucasian predicted higher scores on Score DT compared to being Hispanic (*Beta* = -.192, $p < .05$). Finally, the overall model predicting the Code Transmission subtest was significant, $F\,(2, 155) = 3.56, p < .05, R^2 = .044$. Being Caucasian predicted higher scores on Code Transmission compared to being African-American (*Beta* = -.210).

Table 13

Summary of Multiple Regression Analysis Predicting Test of Everyday Attention Subtests from Ethnicity

	Unstandardized					Overall Model		
	B	SE	Beta	*t*	*p*	*F*	*p*	R^2
Sky Search						.57	.568	.007
African American[a]	.200	.57	.029	.35	.726			
Hispanic[a]	.712	.68	.086	1.05	.295			
Map Mission						.92	.401	.012
African American[a]	-.720	.55	-.108	-1.31	.193			
Hispanic[a]	-.373	.64	-.048	-.59	.559			

(Table 13, continued)

Table 13, continued

	Unstandardized					Overall Model		
	B	SE	Beta	t	p	F	p	R^2
Score!						5.61	.004	.067
African American[a]	-1.241	.69	-.142	-1.81	.072			
Hispanic[a]	-2.526	.82	-.244	-3.09	.002			
Score DT						3.45	.034	.043
African American[a]	-.989	.68	-.116	-1.45	.149			
Hispanic[a]	-1.955	.81	-.192	-2.41	.017			
Walk, Don't Walk						.78	.459	.010
African American[a]	1.131	.94	.098	1.21	.228			
Hispanic[a]	.583	1.11	.043	.52	.601			
Code Transmission						3.56	.031	.044
African American[a]	-1.790	.68	-.210	-2.63	.009			
Hispanic[a]	-.732	.81	-.072	-.90	.368			
Sky Search DT						.73	.483	.010
African American[a]	-.222	.71	-.026	-.31	.755			
Hispanic[a]	-.990	.82	-.099	-1.20	.230			
Creature Counting						2.31	.102	.029
African American[a]	.373	.66	.046	.57	.572			
Hispanic[a]	-1.522	.78	-.156	-1.94	.054			
Opposite Worlds						1.93	.149	.024
African American[a]	-.876	.68	-.104	-1.29	.200			
Hispanic[a]	-1.367	.81	-.136	-1.69	.094			

Note. [a]Compared to Caucasian

Additional Analysis

A series of multiple linear regressions predicting each of the nine subtest scores from age, gender, ethnicity, and parent education were conducted, see Table 14. Significant overall models were found for the Map Mission, Score!, Score DT, and Creature Counting subtests. Although only the findings with outliers removed are shown, all findings were confirmed with outliers included.

The findings revealed that the overall model predicting the Map Mission subtest was significant, F (6, 146) = 3.54, $p < .01$, $R^2 = .127$. Being female was predictive of higher Map Mission scores compared to being male (*Beta* = .238, $p < .01$). Age, ethnicity, and parent education were not significant predictors of Map Mission.

The findings revealed that the overall model predicting the Score! subtest was significant, F (6, 151) = 3.45, $p < .01$, $R^2 = .121$. Younger ages predicted higher Score! scores compared to being older (*Beta* = -.202, $p < .01$). In addition, being Caucasian was predictive of higher Score! scores compared to being Hispanic (*Beta* = -.219, $p < .01$). Level of parent education was not a significant predictor of Score!.

The findings revealed that the overall model predicting the Score DT subtest was significant, F (6, 146) = 2.31, $p < .05$, $R^2 = .084$. However, none of the predictors were individually significant. There was a trend that being Caucasian compared to Hispanic was predictive of higher Score DT scores (*Beta* = -.140, $p = .094$). Age, gender, and parent education were not significant predictors of Score DT.

The findings revealed that the overall model predicting the Creature Counting subtest was significant, F (6, 151) = 2.53, $p < .05$, $R^2 = .091$. Similarly to the model predicting the Score DT model, none of the individual predictors were individually significant but there were several predictors that were trending towards being significant. Older age (*Beta* = .148, $p = .060$), being female (*Beta* = .135, $p = .085$), and having more than High School education (*Beta* = .213, $p = .064$) were predictive of higher Creature Counting scores. Ethnicity was not a significant predictor of Creature Counting. All findings confirmed with outliers included.

Table 14

Summary of Multiple Regression Analysis Predicting Test of Everyday Attention Subtests from Ethnicity, Gender, Age, and Parent Education

	Unstandardized					Overall Model		
	B	SE	Beta	t	p	F	P	R^2
Sky Search						.69	.654	.027
Age	.189	.16	.099	1.22	.226			
Female[a]	-.378	.44	-.070	-.86	.391			
African American[b]	.117	.58	.017	.20	.840			
Hispanic[b]	.513	.71	.062	.72	.473			
Completed High School[c]	-.615	.74	-.098	-.83	.409			
More than High School[c]	-.190	.65	-.034	-.29	.771			
Map Mission						3.54	.003	.127
Age	.277	.14	.153	1.97	.051			
Female[a]	1.215	.40	.238	3.07	.003			
African American[b]	-.709	.53	-.106	-1.33	.186			
Hispanic[b]	-.109	.64	-.014	-.17	.866			
Completed High School[c]	.998	.69	.171	1.45	.149			
More than High School[c]	.073	.61	.014	.12	.905			

(Table 14, continued)

Table 14, continued

	Unstandardized B	SE	Beta	t	p	Overall Model F	P	R^2
Score!						3.45	.003	.121
Age	-.483	.18	-.202	-2.62	.010			
Female[a]	.725	.52	.107	1.40	.163			
African American[b]	-1.069	.68	-.123	-1.56	.120			
Hispanic[b]	-2.270	.84	-.219	-2.69	.008			
Completed High School[c]	.277	.88	.036	.32	.752			
More than High School[c]	.436	.77	.063	.56	.573			
Score DT						2.31	.036	.084
Age	-.227	.18	-.097	-1.23	.220			
Female[a]	.826	.52	.125	1.59	.113			
African American[b]	-.804	.68	-.094	-1.18	.242			
Hispanic[b]	-1.424	.84	-.140	-1.69	.094			
Completed High School[c]	1.342	.88	.177	1.53	.128			
More than High School[c]	1.201	.77	.178	1.56	.122			
Walk, Don't Walk						.36	.901	.014
Age	-.162	.26	-.051	-.63	.529			
Female[a]	.285	.72	.032	.39	.695			
African American[b]	1.155	.96	.100	1.21	.230			
Hispanic[b]	.567	1.18	.041	.48	.632			
Completed High School[c]	-.318	1.23	-.031	-.26	.795			
More than High School[c]	-.069	1.08	-.008	-.06	.949			
Code Transmission						1.82	.100	.067
Age	-.091	.19	-.039	-.49	.624			
Female[a]	.573	.52	.087	1.10	.274			
African American[b]	-1.658	.69	-.194	-2.40	.017			
Hispanic[b]	-.324	.85	-.032	-.38	.704			
Completed High School[c]	.915	.88	.120	1.04	.302			
More than High School[c]	1.180	.78	.175	1.52	.131			

(Table 14, continued)

Table 14, continued

	Unstandardized B	SE	Beta	t	p	Overall Model F	P	R^2
Sky Search DT						.48	.826	.019
Age	-.110	.19	-.047	-.57	.571			
Female[a]	.466	.54	.071	.86	.389			
African American[b]	-.234	.73	-.027	-.32	.749			
Hispanic[b]	-1.066	.88	-.107	-1.22	.225			
Completed High School[c]	-.317	.92	-.042	-.34	.732			
More than High School[c]	-.481	.81	-.072	-.59	.555			
Creature Counting						2.53	.023	.091
Age	.333	.18	.148	1.90	.060			
Female[a]	.857	.49	.135	1.73	.085			
African American[b]	.375	.65	.046	.57	.566			
Hispanic[b]	-1.090	.81	-.112	-1.35	.178			
Completed High School[c]	1.125	.84	.154	1.35	.181			
More than High School[c]	1.375	.74	.213	1.87	.064			
Opposite Worlds						1.03	.408	.039
Age	-.050	.19	-.021	-.27	.790			
Female[a]	.706	.52	.108	1.35	.181			
African American[b]	-.842	.69	-.100	-1.21	.227			
Hispanic[b]	-1.177	.86	-.117	-1.37	.171			
Completed High School[c]	.237	.89	.032	.27	.790			
More than High School[c]	.508	.78	.076	.65	.517			

Note. [a]Compared to male; [b]Compared to African-American; [c]Compared to Less than High School

Summary

In summary, both the demographic and dependent variables were tested, as were the relationships between these variables. Hypothesis testing was done using nonparametric Kruskal-Wallis and Mann Whitney U tests and simple linear regressions.

In general, the hypotheses were either not supported or found very few of the hypothesized differences. Additional analyses using multiple linear regressions to predict each of the subtests were also reported and help to identify the variables that were important as predictors of several of the subtests. Overall findings suggest that other participant characteristics, not tested in the current study, are important to the TEA-Ch subtest scores.

CHAPTER V

DISCUSSION

This study was done in an attempt to add to the research base regarding demographic and developmental differences in attention in school-age children. The aim was to examine whether the factors of gender, parental level of education, and ethnicity contribute significantly to differences in attentional skills across participants using the TEA-Ch to provide a standardized, multidimensional measurement of attention. This chapter includes a discussion of each hypothesis, as well as a discussion of the limitations of the study and future directions.

Hypotheses One-Two

Hypotheses one and two addressed gender-level differences in attentional skills. It was expected that girls would score higher than boys on sustained attention subtests and on selective attention subtests. It was also hypothesized that there would be no significant difference between girls' scores and boys' scores on shifting attention subtests. The results indicated that there was no significant difference between genders on sustained attention measures. However, there was a significant difference in gender performance on the Map Mission subtest, a measure of selective attention, with females scoring significantly higher than males. There was also a significant gender difference on the Creature Counting subtest, a measure of shifting attention, with females scoring higher than males.

These findings partially supported the hypothesis that girls would outperform boys in selective attention measures, but did not support the hypotheses regarding sustained or shifting attention. While research suggests that gender differences in attention typically favor girls (Bardos et al., 1992; Klenberg et al., 2001; Pascualvaca et al., 1997), several studies have found no gender differences or have found that boys actually outperform girls on certain attention tasks (Lin et al., 1999; Seidel & Joscho, 1990). In regards to sustained attention, Seidel and Joscho (1990) did not find a significant gender difference in sustained attention on a visual CPT, and Lin and colleagues (1999) found that boys actually outperformed girls with regard to hit rate and sensitivity on a CPT paradigm.

In regards to shifting attention, it was expected that there would be no gender difference when in fact girls performed significantly better than boys on the Creature Counting subtest. The majority of research measuring shifting attention in children has utilized the Wisconsin Card Sorting Test (WCST) as a measurement tool, and it is this research that suggests no gender differences in the area of shifting attention. One possibility for the present study's contradictory findings is that the Creature Counting subtest on the TEA-Ch has slightly different task demands than the WCST, which could lead to discrepant results. Also, it is worth noting that while the difference between males and females on Creature Counting and Map Mission was statistically significant, the difference is slight enough to not carry a great deal of clinical significance in an applied setting.

Hypothesis Three

It was hypothesized that as parental education level increased, scores on each of the nine subtests would improve. This hypothesis was not supported, as there was not a significant relationship between parental education and the TEA-Ch measures. This result is particularly unexpected given the well-documented association between poor attention and low SES (Campbell et al., 1986; Palfrey, Levine, Walker, & Sullivan, 1985; Stevens, 1981).

However, the same research also suggests that the relationship between poor attention and low SES is complex, in that a number of negative life circumstances typically associated with low SES (i.e. higher maternal stress, more parental divorce, poorer psychological treatment compliance) could have a negative impact on a child's attentional skills (Albee, 1991; Biederman, 1990, Campbell et al., 1986, Gingerich et al., 1998). The present study did not investigate any negative life circumstances in participants associated with parental education level, which may have impacted the results. Furthermore, the present study relied upon parental education level to represent the broader category of socioeconomic status, and a measure such as mean family income or the Hollingshead Index may have provided a more comprehensive view.

Hypothesis Four

It was hypothesized that ethnicity (i.e. Caucasian, African American, and Hispanic) would not be predictive of any of the nine subtest scores. Overall, results indicated a significant relationship between ethnicity and the TEA-Ch measures. Specifically, on the Score! subtest and the Score DT subtest, both measures of sustained attention, Caucasians scored significantly higher than Hispanics. Also, Caucasians scored significantly higher than African Americans on the Code Transmission subtest, which measures sustained attention.

Research examining the relationship between ethnicity and attentional skills in typically functioning children is extremely limited. The only study to date examining attentional skills in Caucasian, African American, and Hispanic children without ADHD found that African American and Hispanic children were less distracted by interference during the attention task than Caucasian children, and Hispanic children had the most proficient reaction time on the attention task (Mezzacappa, 2004).

The current study differed from Mezzacappa's (2004) study in several regards, most notably the age range of the children in the respective studies. The participants in Mezzacappa's study ranged in age from 4 to 7 years, while the participants in the current study ranged in age from 6 to 15.11 years, resulting in an older group of participants in the current study. Research indicates that attentional skills develop at different rates across childhood (Levy, 1980; Luria, 1959; Mahone et al., 2001), so hypothesizing about the attentional performance of school-age children based on research concerning preschool children may have lead to inaccurate assumptions. The current study adds to the breadth of research surrounding attentional skills in an ethnically diverse sample of school-age children. More research is needed examining attentional skills in healthy school-age children from various ethnic and racial groups.

Additional Analysis

Additional analysis in the form of simple and multiple regressions were conducted to examine the amount of variance accounted for by demographic variables in predicting each of the nine subtest scores. First, simple linear regressions were completed predicting each of the nine subtest scores from ethnicity. On the Score! subtest, 6.7% of the variance was predicted, with being Caucasian predicting higher scores compared to being Hispanic. On the Score DT subtest, 4.3% of the variance was predicted from ethnicity, with being Caucasian again predicting higher scores compared to being Hispanic. On the Code Transmission subtest, 4.3% of the variance was predicted by ethnicity, with being Caucasian predicting higher scores compared to being African American.

Multiple linear regressions were also completed predicting each of the nine subtest scores from each of the demographic variables: age, gender, ethnicity and parental education level. On the Map Mission subtest, 12.7% of the variance was predicted, with younger age predicting higher scores and being Caucasian (compared to being Hispanic) also predicting higher scores. On the Score! subtest, 12.1% of the variance was predicted with younger age again predicting higher scores and being Caucasian (compared to being Hispanic) also predicting higher scores. On the Score DT subtest, 8.4% of the variance was predicted, with being Caucasian predicting higher scores compared to being Hispanic. On the Creature Counting subtest, 9.1% of the variance was predicted. The overall model was significant, but all predictors were marginal. Older age marginally predicted higher scores, being female marginally predicted higher scores, and having a parent with more than a high school education also marginally predicted higher scores.

Results of the multiple linear regressions suggest that some of the variability in TEA-Ch subtests scores across participants can be attributed to factors that were not included or controlled for in the current study. Intelligence is one such factor that was not formally measured in the present study. Having an identified disabling condition or having been evaluated for Special Education was an exclusionary criterion for the study, and this criterion was included in order to ensure that the participants were free of disabling conditions and were of roughly average cognitive functioning.

However, assuming that children who do not receive Special Education services are of average intelligence may be presumptive, as a broad range of cognitive ability exists outside the realm of Special Education. Administering a standardized intelligence test to participants may have provided a more accurate representation of intellectual functioning across the participant group. Studies have reported about the relationship between various measures of intelligence and tasks of sustained attention (Seidel & Joscho, 1990) and tasks of shifting attention in children (Foley, Garcia, Shaw, & Golden, 2005). Future studies may wish to include a standardized measure of intellectual ability given the impact intelligence may have on the development and expression of attentional processes in children.

Limitations and Future Research

Several limitations are worth noting in the current study. First, while the sample size was large enough to have adequate effect sizes, it was not as large as initially intended. A larger sample would likely have resulted in more normal distribution of subtest scores, which would have made the use of parametric statistics more appropriate. Parametric statistics would have made it possible to examine interactions between the independent variables. The oldest age group in the sample (13.0-15.11) was underrepresented in the sample, thus limiting the conclusions that can be drawn from results regarding this age group. Futhermore, only 42 of the 158 study participants resided outside of the North Texas area, thus limiting the generalizability of results to other geographic regions of the country.

Another limitation worth noting is the possibility of measurement error. Factors such as distractibility, fatigue, nervousness, motivation, and misinterpretation of directions may have influenced the participants' performance. Furthermore, the variability of testing sites may have influenced test performance, as certain sites likely had more distractions and less privacy than other sites.

Future research with larger sample sizes and better representation from various age, geographic, and ethnic groups would produce results that are more generalizable to the U.S. population at large. Instead of relying solely upon parental education level, future studies should consider including a measure of mean family income or the Hollingshead Index to gain a more comprehensive view of socioeconomic status. In regards to ethnicity, future studies should consider including a measure of acculturation, as factors such as the amount of time in the United States and English language acquisition may influence test performance. Future research should also include a standardized intelligence measure to formally control for the effect of intelligence on attentional skills. The inclusion of a clinical group (such as children with ADHD) in future studies would offer information about the sensitivity of the TEA-Ch for use with clinical populations of U.S. children.

Summary

The current study was a preliminary attempt to examine developmental and demographic differences in childhood attention with the TEA-Ch, a neuropsychological measure of attention that has received little research attention in the United States. The TEA-Ch is a unique instrument as it directly measures multiple aspects of attention, as opposed to subjective behavior ratings of attention completed by parents or teachers. School psychologists using the TEA-Ch as part of a comprehensive evaluation will gain insight into a child's attentional strengths and weaknesses. Having detailed attentional information will in turn aid in the development and implementation of interventions to address attentional deficits in the classroom.

The current study adds to the literature base surrounding demographic differences in attention amongst U.S. children using the TEA-Ch to obtain a standardized, multi-dimensional measurement of attention. While many of the expected findings were not confirmed, the obtained information is useful in that it adds to the limited research base surrounding demographic variables and attention and also adds to the limited research exposure of the TEA-Ch in a U.S. population. In particular, the relationship between ethnicity and childhood attentional skills is under-researched, and the current study provides preliminary data concerning the relationship between ethnicity and attention.

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APPENDIX A

IRB Letter

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378 FAX 940-898-4416
e-mail: IRB@twu.edu

February 16, 2011

Dr. Daniel Miller
CFO 708

Dear Dr. Miller:

Re: Cross Validation Study of the Test of Everyday Attention for Children (TEA-Ch) (Protocol #: 15019)

The request for an extension of your IRB approval for the above referenced study has been reviewed by the TWU Institutional Review Board (IRB) and appears to meet our requirements for the protection of individuals' rights.

If applicable, agency approval letters must be submitted to the IRB upon receipt PRIOR to any data collection at that agency. A copy of all signed consent forms and an annual/final report must be filed with the Institutional Review Board at the completion of the study.

This extension is valid one year from March 15, 2011. Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

Sincerely,

Dr. Kathy DeOrnellas, Chair
Institutional Review Board - Denton

cc.

APPENDIX B

Recruitment Script

Test of Everyday Attention (TEA-Ch) U.S. Validation Study

Recruitment of Participant Script

Note to Examiner: After you have identified a possible child to test, please read the following script to the parent:

Based on your child's sex and age, I would like to see if [insert child's name here] qualifies to participate in a research study. The purpose of the study is to have a broad group of U.S. children take a test called the Test of Everyday Attention. The test was originally developed in Australia and the purpose of this study is to determine if children in the U.S. perform similarly on the test.

If you would agree to have your child participate in this study, the Test of Everyday Attention would be individually administered to your child by me, a trained examiner. The test would take about 45 to 60 minutes to administer. After the test was scored, I would provide you with a summary sheet showing how your child scored on the test in several areas of attention. There would be no charge to you for having your child participate in this study.

In order to see if your child qualifies to participate in this study, I need to ask you a few questions to see if your child matches the characteristics of children the researchers are looking for to complete the U.S. sample. Your answers to these questions will be kept confidential and are used only to see if your child qualifies for the study.

Are you willing to answer a few questions to see if your child qualifies for the study?

If the parent says No.

That's fine. Thank you for talking to me today. If you have any questions about the study you can call the Principal Investigator, Dr. Dan Miller at 940-898-2251.

If the parent says Yes, go on..........

Thank you. Here are the questions to see if your child qualifies to participate in the study.

1. *Has your child ever been evaluated for having special educational needs?*

    ____ If yes, stop questions and go to the non-qualified statement at the bottom.

    ____ If no, continue with question #2

2. *Has your child's teacher ever expressed any serious concerns to you about your child's ability to pay attention?*

    ____ If yes, stop questions and go to the non-qualified statement at the bottom.

    ____ If no, continue with question #3

3. *Has your child's teacher ever expressed any serious concerns to you about your child's ability to learn at school?*

____ If yes, stop questions and go to the non-qualified statement at the bottom.

____ If no, continue with question #4

4. *Has your child ever been diagnosed as being developmentally delayed or having a serious sensory (e.g., hearing or vision) loss?*

____ If yes, stop questions and go to the non-qualified statement at the bottom.

____ If no, continue with question #5

5. *Has your child ever had a serious head injury that resulted in a loss of consciousness or had any serious neurological illness such as epilepsy, meningitis, or cerebral palsy?*

____ If yes, stop questions and go to the non-qualified statement at the bottom.

____ If no, continue with question #6

6. *What is [insert child's name here]'s principle ethnicity?*

____ Caucasian
____ Hispanic
____ African American
____ Other
Examiner: Does the child's ethnicity match a targeted child in the validation sample?
____ If no, stop questions and go to the non-qualified statement at the bottom.
____ If yes, continue to question #7

7. *What is your relationship to the child?*
____ Mother
____ Step-mother
____ Father
____ Step-father
____ Other (specify: ________________________)

8. What category would best describe the your highest educational training?
____ did not complete High School
____ Completed High School
____ Completed 2 or more years of college or completed a trade school
____ Completed 4 years of college
____ Completed a graduate degree
Examiner: Does the parent/guardian's educational level match a targeted child in the validation sample?
____ If no, stop questions and go to the non-qualified statement at the bottom.
____ If yes, read the following statement:
Great, it looks like your child qualifies to participate in this study. What happens next is that I will need you to sign and permission slip to allow me to administer the Test of Everyday Attention to your child and to schedule a time for the testing. When the testing if completed and I have a chance to score the test, I will provide you a summary of the results. [Work out the logistics with the parent] I appreciate you talking to me today and if you have any questions about this study, you can call the principal investigator, Dr. Dan Miller at 940-898-2251.

Non-Qualified Statement:

Based on your answer(s), your child does not qualify to participate in this study. I appreciate you talking to me today and if you have any questions about this study, you can call the principal investigator, Dr. Dan Miller at 940-898-2251.

APPENDIX C

Consent Form (English version)

TEXAS WOMAN'S UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: Cross-Validation Study of the Test of Everyday Attention for Children (TEA-Ch)

Principal Investigators: Daniel C. Miller, Ph.D. 940/898-2251

Kristen Belloni, M.A.

Joy Whitehead, M.A.

Explanation and Purpose of the Research

You are being asked to allow your child to participate in a research study for faculty research, dissertation purposes, and for Pearson Assessment. The purpose of this research is to determine the validity of using the Test of Everyday Attention for Children (TEA-Ch) with children in the United States. The test has been normed on an Australian population, which may or may not make the test appropriate for use with children in the United States.

Research Procedures

For this study, scores on the TEA-Ch will be collected from a variety of sources. Research investigators will gather data by testing students in the United States. The administration will be done at a private location agreed upon by you and the investigator. The test is comprised of nine subtests, and your maximum total time commitment in the study is approximately one hour.

Potential Risks

Potential risks related to your child's participation in the study include fatigue and physical or emotional discomfort during the testing. To avoid fatigue and physical discomfort, your child may take a break (or breaks) in between subtests as needed. If your child experiences fatigue, physical or emotional discomfort regarding the testing, he/she may stop at any time. The investigator will provide all participants with a referral list of names and phone numbers that you may use if you feel as though you or your child need to discuss this discomfort with a professional.

Another possible risk to your child as a result of your participation in this study is a release of confidential information. There is a potential risk of loss of confidentiality in all email, downloading, and internet transactions. Confidentiality will be protected to the extent that is allowed by law. The test administration will take place in a private location agreed upon by you and the researcher. A code name, rather than your child's real name, will be used on the test materials. Only the investigator and research investigators will have access to the testing materials. The materials will be shredded within two years. It is anticipated that the results of this study will be published in the investigators' (Daniel Miller, PhD, Kristen Belloni and Joy Whitehead) research publications and dissertations, and by Pearson Assessment in the re-norming of the TEA-Ch. However, no names or other identifying information will be included in any publication.

The researchers will try to prevent any problem that could happen because of this research. You or your child should let the researchers know at once if there is a problem and they will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because your child is taking part in this research.

Participation and Benefits

Your child's involvement in this research study is completely voluntary, and you or your child may discontinue participation in the study at any time without penalty. As a benefit of your participation in this study **you will receive a summary of the results** and your child will receive a small age-appropriate reward at the completion of the test administration.

Questions Regarding the Study

If you have any questions about the research study you may ask the principal investigator; his phone number is at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940/898-3378 or via email at IRB@twu.edu. You will be given a copy of this signed and dated consent form to keep.

By signing this form, the child participant is assenting to participate in this testing and the parent/guardian is consenting to the child participant's involvement.

____________________________________ _______________

Signature of Participant Date

____________________________________ _______________

Signature of Parent/Guardian Date

If you are interested in having your child participate in the study, please complete the following information to determine if he/she qualifies for the study and return the form to your child's teacher/after school program/ or summer program in the attached sealed envelope.

Please remember that your child **<u>does not</u>** qualify for the study if:
-the child has been identified as learning disabled OR has identified attention problems
-the child has been evaluated for special education services
-the child has experienced a serious head injury (resulting in loss of consciousness) or had a serious neurological illness (such as epilepsy, cerebral palsy, etc.)

Child's Name: ____

Child's gender: ☐Male☐Female
Child's Date of Birth: ________________ Child's Age: _____________
Child's Ethnicity: ____________________________

<u>Mother's Highest Level of Education</u>: (check one)
☐ Less than a High School Education
☐ Completed High School
☐ Completed 2 or more years of college or completed a trade school
☐ Completed 4 years of college
☐ Completed a graduate degree

<u>Father's Highest Level of Education:</u> (check one)
☐ Less than a High School Education
☐ Completed High School
☐ Completed 2 or more years of college or completed a trade school
☐ Completed 4 years of college
☐ Completed a graduate degree

APPENDIX D

Consent Form (Spanish version)

TEXAS WOMAN'S UNIVERSITY

CONSENTIMIENTO PARA PARTICIPAR EN UNA INVESTIGACIÓN

Título del estudio: Estudio de validación cruzada de la prueba de atención diaria para los niños (TEA-ch – por sus siglas en ingles)

Investigadores principales: Daniel C. Miller, Ph.d. 940/898-2251

Kristen Belloni, M.A.

Joy Whitehead, M.A.

Explicación y propósito de la investigación

Estamos solicitando permiso para que su niño/ a participe en una investigación para estudios de la facultad, para las disertaciones o tesis y para la evaluación de Pearson. El propósito de esta investigación es para determinar la validez del uso de la Prueba de Atención Diaria para Niños (TEA-ch) con niños en los Estados Unidos. La prueba ha sido normalizada en una población australiana, que puede o no puede hacer que la prueba sea apropiada para su uso con niños en los Estados Unidos.

Procedimientos de investigación

Para este estudio, se recopilarán puntuaciones en el TEA-ch de una variedad de fuentes. Los investigadores reunirán datos mediante pruebas a los estudiantes en los Estados Unidos. La administración se llevará a cabo en un lugar privado acordado por usted y el investigador. La prueba está compuesta por nueve subpruebas y el de tiempo total para completar la evaluacion es de aproximadamente una hora.

Posibles riesgos

Posibles riesgos relacionados con la participación de su hijo en el estudio incluyen la fatiga y el malestar físico o emocional durante las pruebas. Para evitar la fatiga y el malestar físico, su hijo puede tomar un descanso (o descansos) entre subpruebas según sea necesario. Si su niño siente fatiga, malestar físico o emocional, con respecto a las pruebas, pueden detener las pruebas en cualquier momento. El investigador ofrecerá a todos los participantes una lista de nombres y números de teléfono que usted puede utilizar si siente que su niño/a necesita discutir la molestia con un profesional.

Otro riesgo posible a su hijo como resultado de su participación en este estudio es que él o ella ofrezca información confidencial. Existe un riesgo potencial de pérdida de confidencialidad en todo correo electrónico, las descargas y las transacciones de internet. La confidencialidad será protegida en la medida en que es permitido por la ley. La administración de la prueba se llevará a cabo en un lugar privado acordado por usted y el investigador. Un nombre en código será usado en lugar del nombre real de su hijo en los materiales de prueba. Sólo los investigadores tendrán acceso a los materiales de pruebas.

Los materiales serán destruidos dentro de dos años. Anticipamos que los resultados de este estudio salgan en publicaciones y disertaciones de los investigadores (Daniel Miller, PhD, Kristen Belloni y Joy Whitehead) y en la re normalización de la evaluación de Pearson de la TEA-ch. Sin embargo, nombres u otra información de identificación no se incluirán en las publicaciones.

Los investigadores tratan de evitar cualquier problema que pueda suceder debido a esta investigación. Usted o su niño/a deben dejarle saber a los investigadores si hay un problema y ellos les ayudarán. Sin embargo, TWU no proporciona servicios médicos o de asistencia financiera para las lesiones que podrán suceder debido a la participación de su hijo/a en esta investigación.

Participación y beneficios

La participación de su hijo en este estudio de investigación es totalmente voluntaria y usted o su niño puede retirase del estudio en cualquier momento sin ser penalizado. Como beneficio de su participación en el estudio, **usted recibirá un resumen de los resultados** y su hijo recibirá una pequeña recompensa apropiada para la edad de él o ella al finalizar la administración de la prueba.

Preguntas acerca del estudio

Si tienes alguna pregunta sobre el estudio puede hacérselas al investigador principal; su número de teléfono está en la parte de arriba de este formulario. Si tiene preguntas acerca de sus derechos como participante en esta investigación o la forma en que se ha llevado a cabo este estudio, puede comunicarse con la Oficina de Investigaciónes y Programas Patrocinados de Texas Women's University al 940/898-3378 o a través de correo electrónico a IRB@twu.edu. Se le dará una copia de este formulario de consentimiento firmado y fechado para sus archivos.

Al firmar este formulario, el niño está aceptando participar en esta prueba y el padre o tutor está de acuerdo con la participación del niño en la investigación.

_______________________________________ ____________

Firma del participante Fecha

_______________________________________ ____________

Firma del padre/guardián Fecha

Si les interesa que su hijo/a participe en la investigación, por favor complete la siguiente información para determinar si califica para el estudio y regrese el formulario al maestro de su hijo, al programa después de la escuela o al programa de verano en el sobre sellado que está adjunto a estas hojas.

Por favor, recuerde que su niño **no** califica para el estudio si:
-el niño ha sido identificado como estudiante con problemas de aprendizaje o de atención
-el niño ha sido evaluado para determinar si necesita servicios de educación especial
-el niño ha sufrido una lesión grave en la cabeza (la cual resultó en la pérdida de la conciencia) o hubo una enfermedad neurológica grave (como parálisis cerebral, epilepsia, etc..)

Nombre del niño/a:
____

☐ Niño ☐Niña
Fecha de nacimiento: ________________ Edad: ____________
Etnicidad del niño/a: ______________________________

Nivel de educación más alto que ha obtenido la mamá: (circule uno)
Menos que la educación secundaria
Terminó la escuela secundario
Completó 2 años o más de universidad o
completó una escuela de comercio
Completó 4 años de universidad
Obtuvo un título de posgrado

Nivel de educación más alto que ha obtenido la papá: (circule uno)
Menos que la educación secundaria
Terminó la escuela secundario
Completó 2 años o más de universidad o
completó una escuela de comercio
Completó 4 años de universidad
Obtuvo un título de posgrado

APPENDIX E

Feedback Results Page

Test of Everyday Attention (TEA-Ch) U.S. Validation Research Study

Summary of Individual Child's Results

Child's Name: ____________________________ Child's Age: _________ Date of Testing: ______________

	Scaled Score																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Selective/Focused Attention																			
• Sky Search																			
o Number of correctly identified targets																			
o Time per target																			
o Attention Score																			
• Map Mission																			
Sustained Attention																			
• Score!																			
• Score DT																			
• Walk, Don't Run																			
• Code Transmission																			
Divided Attention																			
• Sky Search DT																			
Attentional Control / Shifting Attention																			
• Creature Counting																			
o Total Correct																			
o Timing Score																			
• Opposite Worlds																			
o Same World Total																			
o Opposite World Total																			

Scaled scores between 7-13 are classified as average or at an expected level for your child's age. Scaled scores less than 7 are below an expected level for your child's age and scaled scores greater than 13 are above an expected level for your child's age.

Selective/Focused Attention – the ability selectively focus attention on something "important" to pay attention to, while ignoring things that are not important to pay attention to. An example would be paying attention to a school lesson rather than noises of cars driving by the school.

Sustained Attention – the ability to stay of task for a prolonged period of time. An example would be a child's ability to concentrate on a video game for a long period of time.

Divided Attention – the ability to respond to more than one task or an event at a time. An example would be a child responding to a question while playing a video game.

Attentional Control / Shifting Attention – the ability to consciously reallocate attentional resources from one activity to another. An example would be a child transitioning from one school task to another.

These results are intended for research purposes and are not to be used for diagnosing attentional processing disorders. If you have concerns about your child's performance on this test, consult with a school psychologist, an educator, or a family physician.