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The Effects of Auditory Stimulation on Academic and Behavior Performance in Children With and Without Attention-Deficit/Hyperactivity Disorder

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THE EFFECTS OF AUDITORY STIMULATION ON ACADEMIC AND BEHAVIORAL PERFORMANCE IN CHILDREN WITH AND WITHOUT ATTENTION-DEFICIT/ HYPERACTIVITY DISORDER

by

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ABSTRACT

The Effects of Auditory Stimulation on Academic and Behavior Performance in Children With and Without Attention-Deficit/Hyperactivity Disorder

by

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This study evaluated the relationship between noise and academic performance and behavior of children with ADHD ($n = 15$) and without ADHD ($n = 18$). Children completed math sheets under four noise conditions: no noise, standard classroom noise, classroom noise with verbalizations, and classroom noise with classical music. There were no differences in math performance between the two groups. Children with ADHD exhibited more problem behaviors than children without ADHD. Group-by-condition interactions were not significant. Significant effects were found for noise condition; children completed more math problems and had fewer inappropriate behaviors in the no-noise condition. However, there were significant order effects with children performing better on the initial task. The no-noise condition was always presented first; other conditions were randomized. Thus, it is impossible to determine if improved performance was due to decreased environmental stimulation or initial performance effects. Implications of these findings are discussed.

(87 pages)

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CHAPTER I

INTRODUCTION

For many years ecological psychologists have recognized the potential importance of the environmental settings of classrooms on the academic performance of children (Jerison, 1959; Kottmeyer, 1971). Such research has focused on environmental variables, which include noise (Bronzaft & McCarthy, 1975; Cohen, Evans, Krantz, & Stokols, 1980; Jerison; Kottmeyer; Spradlin, Cromwell, & Foshee, 1959), lighting (Fletcher, 1983; Ott, 1976), and various other visual stimulation (Fletcher; Gardner, Cromwell, & Foshee, 1959; Ott; Zentall, 1977).

In general, increased visual stimulation (i.e., rooms decorated with brightly colored cloths, various toys, and Christmas lights) has been associated with a decrease in hyperactive behavior and an improvement in academic performance (Forehand & Baumeister, 1970; Gardner et al., 1959; Tizard, 1968). Research on lighting indicates fluorescent tubes are associated with an increase in off-task behavior, while light with a full light spectrum decreases off-task behavior (Fletcher, 1983; Ott, 1976). An increase in auditory stimulation has also been associated with decreased hyperactive behavior in children with hyperactivity, although somewhat less consistently. Many factors have been hypothesized to influence the effects that various auditory stimuli have on the behavior and academic performance of children with hyperactivity. Such factors include: individual differences in stimulation needs (Somerville, Warnberg, & Bost, 1973; Zentall, 1975, 1977); type of auditory stimulation (Reardon & Bell, 1970; Scott, 1970; Zentall & Shaw, 1980); and task difficulty and task requirements (Levitt &

Kaufman, 1965; Pope, 1970; Steinschneider, Lipton, & Richmond, 1966; Whalen, Henker, Collins, Finck, & Domtemoto, 1979; Zentall & Shaw).

Numerous researchers have examined the relationship between environmental setting and classroom performance in children with high levels of hyperactivity and distractability as indicated by behavior rating scales (Zentall & Shaw, 1980; Zentall & Zentall, 1976). However, only one study has been conducted related to environmental noise and its effect on the academic performance of children with a formal diagnosis of attention-deficit/hyperactivity disorder (ADHD; Abikoff, Courtney, Szeibel, & Koplewicz, 1996). When looking at the effects of external auditory stimulation, researchers have pursued two lines of investigation. In one approach the effects of auditory stimulation on behavior have been assessed, and in the other approach the effects of auditory stimulation on academic performance have been examined. Results from the previous studies have been variable and have elicited two main but conflicting theories about the effects of noise on behavior and academic performance tasks with children who exhibit ADHD-like behaviors. One theory suggests that children who exhibit ADHD behaviors are overstimulated, and decreased auditory stimulation results in better academic performance (Cruickshank, Bentzen, Ratzeburg, & Tannhauser, 1961; Strauss & Lehtinen, 1947). In general, studies looking at the effects of reduction in external environmental stimulation have failed to provide sufficient evidence that reduction in stimuli increases academic performance and reduces activity in children with hyperactivity. Conversely, other researchers have reported an improvement in academic performance and decrease in activity level with increased auditory and visual stimulation (Cleland, 1962; Forehand & Baumeister, 1970; Gardner et al., 1959;

Reardon & Bell, 1970; Tizard, 1968; Zentall & Zentall, 1976). Such results provide support for a second theory that suggests children who exhibit ADHD behaviors are underaroused; therefore, the presence of environmental noise leads to improved academic performance and behavior (Zentall & Zentall).

Research looking at the effects of external stimulation on behavior and academic performance could have important implications for improving the academic performance of children with ADHD. Children with ADHD often have difficulty achieving in school. This is often shown through lack of productivity in the classroom and low-level mastery of material (Barkley, Fischer, Edelbrock, & Smallish, 1990; Weiss & Hechtman, 1993). Researchers suggest 46% of children with ADHD are suspended from school at least once, 10-35% never receive a high school diploma, 30% are retained a grade, 30-40% receive special education services, and 56% receive some type of academic tutoring (Barkley, DuPaul, & McMurray, 1990; Barkley, Fischer, et al., 1990; Brown & Borden, 1986; Faraone et al., 1993; Munir, Biederman, & Knee, 1987; Weiss & Hechtman, 1993). In addition, children with ADHD often perform 10-30 standardized points lower on achievement tests than their same age peers (Barkley, DuPaul, & McMurray; Brock & Knapp, 1996; Cantwell & Satterfield, 1978; Casey, Rourke, & Del Dotto, 1996; Fischer, Barkley, Edelbrock, & Smallish, 1990). Because of these startling statistics, it is important to investigate strategies that will improve the academic achievement of children with ADHD.

A variety of treatments are effective for treating children with ADHD in the academic setting including: stimulant medication (Barkley, 1977; Pelham, Carlson, & Sams, 1993; Rapport, DuPaul, Stoner, & Jones, 1986), matching academic tasks to the child's ability (Gickling & Thompson, 1985); assigning brief academic assignments (Abramowitz, Reid, & O'Toole, 1994;); setting short time limits (Pfiffner & Barkley, 1990); varying the presentation format and task materials (Zentall, 1993), and teaching rules and expectations (Pfiffner & Barkley); and using self-monitoring and self-reinforcement to improve academic and social functioning (Whalen & Henker, 1986). Investigation concerning environmental aspects (e.g., noise) and their effects on academic performance in children with ADHD behaviors is scarce, and there is a lack of consensus regarding its effects. Specifically, there is little information on the impact of various auditory stimuli on the academic performance and behavior of children with ADHD. Further research in this area could be useful in the design of academic interventions. If children with ADHD work best in a quiet, noise-free environment, then implications for treatment would include reducing the stimulation in the environment. If research indicates children with ADHD work best in a highly stimulated environment, interventions to increase the stimulation in the academic environment might be warranted. The present study aimed to investigate the relationship between noise and the academic performance and behavior of children with ADHD, as well as those without ADHD.

CHAPTER II

LITERATURE REVIEW

Attention-Deficit/Hyperactivity Disorder

ADHD has been a topic of interest since the early 1900s. Throughout history researchers studied individuals who showed excessive activity and who had difficulties sustaining attention, symptoms that are now considered to be part of ADHD. Although researchers have referred to such symptoms by a variety of different names (e.g., brain-injured child syndrome, hyperkinesis, hyperactive child syndrome, minimal brain dysfunction, and attention-deficit disorder with or without hyperactivity), the symptoms all appear to fit the current definition of ADHD as defined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text revision [*DSM-IV-TR*]; American Psychiatric Association [APA], 2000; Douglas, 1972; Douglas & Peters, 1978; Ebaugh, 1923; Hohman, 1922; Knobel, Wolman, & Mason, 1959; Still, 1902; Stryker, 1925).

In order to receive a diagnosis of ADHD, a child must exhibit symptoms of the disorder prior to age 7 (APA, 2000). Research suggests that the onset of ADHD symptoms often occurs around the ages of 3-4; however, most children do not receive a formal diagnosis of ADHD until after this age (Barkley, DuPaul, & McMurray, 1990; Loeber, Green, Lahey, Christ, & Frick, 1992; Ross & Ross, 1982).

ADHD is a behavior disorder and is currently conceptualized as consisting of three different subtypes: predominantly inattentive, predominantly hyperactive-impulsive, and combined (APA, 2000). Although children with ADHD often share common symptoms, each individual diagnosed with ADHD will exhibit a unique combination of ADHD symptoms. The type of ADHD diagnosis a child receives is dependent on whether criteria are met for either or both symptom lists (i.e. hyperactive/ impulsive, inattentive) in the *DSM-IV-TR* manual (APA).

Inattention

In order to receive a diagnosis of ADHD-predominantly inattentive type, an individual must exhibit six or more symptoms listed under inattention in the *DSM-IV-TR* criteria. Inattentive symptoms are listed in Appendix A. Attention has been described as a multidimensional construct that includes an individual's distractability, alertness, arousal, ability to focus attention, ability to sustain attention, and so forth (Barkley, 1988; Mirsky, 1996). Many inattentive children have a difficult time focusing, sustaining attention, and persisting through tasks (Douglas, 1983). Because of these difficulties, inattentive children often find tasks that require these skills highly aversive and will switch tasks without ever completing the previous task (Barkley, DuPaul, & McMurray, 1990; Barkley & Ullman, 1975; Corkum & Siegel, 1993). Research has also shown that these children are disorganized and often forgetful in daily activities (e.g., remembering their homework). Their work is often messy and they tend to make more careless errors in their work than their peers (Barkley, 1996). Distractibility refers to a child's inability to attenuate what other children his/her same age would be able to ignore (i.e., background noises, people talking, feelings or thoughts that are not relevant to a task). Research results pertaining to the distractibility of children with ADHD have been variable. It remains unclear whether children with ADHD are more distractible than children without ADHD, and, if so, under what conditions these children are more likely to be distracted. Much of the objective research indicates children with ADHD are no more distractible in the presence of extraneous environmental variables during task performance than children without ADHD (Campbell, Douglas, & Morganstern, 1971; Cohen, Weist, & Minde, 1972; Rosenthal & Allen, 1980; Steinkamp, 1980). On the other hand, research looking at visual stimulation has concluded that children with hyperactivity are likely to look at visual tasks more when placed in a nondistracting low stimulation environment (i.e., cubicles); however, there were no corresponding academic performance gains (Shores & Haubrich, 1969). Others have found that children with learning disabilities perform better on tasks with increased peripheral stimulation, including background stimuli distraction on the paper (i.e., green jigsaw puzzle pattern in high background distraction and leaving three fourths of the paper blank for the low visual background) and increased auditory background noise (no extraneous sounds for the low condition and typical classroom noise using different decibel levels for the medium and high distraction levels; Browning, 1967; Carter & Diaz, 1971). Conclusions about the effects of irrelevant stimulation within a task are also not conclusive. Some findings show a detrimental effect of intratask stimulation on the performance of children with ADHD (Barkley, Koplowitz, Anderson, & McMurray, 1997; Rosenthal & Allen). Other findings show an enhancement of performance with intratask (i.e., colored letters on copying material) stimulation (Zentall, Falkenberg, & Smith, 1985). Still other research shows intratask stimulation to have no effect (Fisher et al., 1993).

Hyperactivity/Impulsivity

Individuals diagnosed with the predominantly hyperactive-impulsive type of ADHD show high levels of hyperactivity and impulsivity, but do not exhibit high levels of inattention. A child must exhibit six or more symptoms of hyperactivity-impulsivity, as indicated in the *DSM-IV-TR* (APA, 2000) criteria to receive a, ADHD-predominantly hyperactive-impulsive type diagnosis (see Appendix A).

A child with hyperactivity will show more excessive motor activity than same-age peers. This excessive motor activity often exhibits itself as being restless or fidgety (Barkley & Cunningham, 1979; Barkley & Ullman, 1975; Porrino et al., 1983; Teicher et al., 1996). Observations of these children in the classroom and during individual task work often show them to exhibit out-of-seat behavior, restlessness and fidgety movements of their limbs while working, unusual vocal noises, talking out of turn, and playing with objects not related to the task at hand (Barkley, DuPaul, & McMurray, 1990; Fischer et al., 1990).

Many of the children diagnosed with the predominantly hyperactive-impulsive type of ADHD act impulsively. Impulsivity has been referred to as the inability to inhibit or delay behaviors that would gain prompt reinforcement such as a reward or escaping from doing an activity (Barkley, 1997a). These children have been described as giving no thought to the consequences of their actions. Often consequences of these actions are negative peer and adult attention (Anastopoulos et al., 1992; Coie et al., 1990) and/or injury from their impulsive behavior (Barkley et al., 1993). Because of their impulsivity, many of these individuals have difficulty controlling their aggression (Milich & Dodge, 1984).

Combined Type

The child who receives a diagnosis of ADHD combined type will exhibit symptoms that are common to both the predominantly inattentive type and the predominantly hyperactive-impulsive type. The diagnostic criteria for ADHD, as indicated by the APA (2000) in the *DSM-IV-TR*, are listed in Appendix A.

Prevalence and Gender Issues

It is estimated that 3-5% of school-aged children have ADHD, with ADHD occurring three times more frequently in boys than girls (DuPaul & Stoner, 1994; Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993; McGee et al., 1990; Szatmari, 1992). The difference in gender prevalence rates has been controversial with some arguing that the ratio is biased due to the fact that the diagnostic criteria for ADHD were developed largely on a male sample (Szatmari). There is a belief that many females get overlooked because they exhibit fewer hyperactive and antisocial behaviors than do males, suggesting the primary symptoms of ADHD might be different in boys and girls. A meta-analysis of research on gender differences in children with ADHD concluded there were no real differences between the behavior of boys and girls within clinical populations (Gaub & Carlson, 1997). However, results from the same meta-analysis did indicate gender differences in community samples. Girls tended to exhibit less hyperactivity, fewer externalizing symptoms (i.e., defiance, conduct behaviors, aggression), and more impairment in intelligence. The significantly higher number of males than females among clinical samples supports the idea of a referral bias, where those individuals exhibiting overt behaviors such as hyperactivity, impulsivity, and aggressive behavior are referred more than those exhibiting nonovert behavior problems such as inattentiveness. The tendency for males to exhibit more antisocial and aggressive behavior than females makes it likely that more boys will be referred for clinical assistance (Befera & Barkley, 1984; Breen & Barkley, 1988; Gaub & Carlson).

Comorbidity

There is substantial evidence of co-occurrence between ADHD and numerous other childhood disorders, suggesting children with ADHD have a significantly higher risk for developing other psychiatric disorders. Comorbitity of ADHD with oppositional defiant disorder (ODD), conduct disorder (CD), antisocial personality disorder (APD), anxiety disorders, and learning disorders (LD) will briefly be discussed. Children with ADHD who have comorbid ODD and CD often have an early onset of aggression and are more likely to have persistent aggression and antisocial behavior into adolescence than children without a comorbid externalizing disorder. It is less likely that a child with ADHD will have comorbid late onset CD (Lahey, Applegate, & Barkley, 1994; Loeber, 1990). The co-occurrence of ODD and ADHD in children older than 7 ranges between 35-60%; 30-50% of those children go on to meet criteria for CD (Barkley, 1998; Biederman, Faraone, & Lapey, 1992), and between 15-25% eventually go on to meet criteria for a diagnosis of APB (Biederman et al.).

The comorbitiy of CD with ADHD increases the severity and persistence of ADHD symptoms compared to children who only have ADHD. Children with ADHD/ CD are more likely to exhibit antisocial behaviors and engage in criminal behavior compared to children with only ADHD (Farrington, Loeber, & Van Kammen, 1989;

Loeber, Brinthaupt, & Green, 1990). Children with a combination of ADHD and CD also show a higher rate of learning disorders than children with only ADHD (McGee, Williams, & Silva, 1984). Additionally, children who have comorbid ADHD/CD and children who have ADHD that persists into adulthood have an increased risk for developing substance abuse problems (McGee et al.).

Of clinic-referred children with ADHD, 25-40% have comorbid anxiety disorders (Biederman et al., 1992; Livingston, Dykman, & Ackerman, 1990; Russo & Biedel, 1994) and between 17-27% of clinic-referred children with anxiety meet criteria for ADHD (Last, Perrin, & Hersen, 1992; Last, Phillips, & Statfeld, 1987). No consistent associations between the subtypes of ADHD and anxiety disorders have been found. Lahey and colleagues (1994, 1992) found anxiety was more frequently comorbid in children with ADHD-predominantly hyperactive/impulsive type than children with ADHD-predominantly inattentive type. However, others have found no differences in the occurrence of anxiety in relation to the two ADHD subtypes (Barkley, DuPaul, & McMurray, 1990; Edelbrock, Costello, Kessler, 1984). Such contradictory results warrant the need for further better-controlled research (Barkley, DuPaul, & McMurray; Biederman et al.; Lahey & Carlson, 1992; Russo & Biedel, 1994). The high rates of comorbitity between ADHD and anxiety disorders emphasize the need for clinicians to assess emotional and behavioral functioning of children with ADHD.

In addition to being at risk for other psychiatric disorders, children with ADHD are at increased risk for developing a formal learning disability, involving a marked discrepancy between intelligence (as measured by intelligence tests) and academic achievement (as measured by academic achievement tests). Estimates of comorbity between the two disorders range from 10-26% (Barkley, 1998; Semrud-Clikeman et al., 1992). Treatments such as stimulant medication have been shown to improve common problems related to school performance (i.e., impulsivity, attention span, and behavioral organization) in children with ADHD; however, these improvements do not necessarily translate into academic gains. Researchers have suggested that children with ADHD who also meet criteria for a learning disability need interventions that are tailored to their specific learning disabilities (Gittelman, Klein, & Feingold, 1983).

Intelligence and Academic Performance

Although not all children with ADHD meet criteria for a LD, many diagnosed with ADHD show deficits in academic achievement (Schachar, 1991). Children with ADHD tend to score lower than those without ADHD on standardized tests of achievement (Barkley, DuPaul, & McMurray, 1990; Brock & Knapp, 1996; Fischer et al., 1990). Many inattentive children have a difficult time completing tasks that require sustained attention and persistence. Because these skills are required on many academic assignments, these assignments are considered to be highly aversive to children with ADHD and often do not get completed (Barkley, DuPaul, & McMurray). Disruptive behaviors and difficulty sustaining attention contribute to the academic underachievement that is characteristic of many children with ADHD (Fischer et al.).

In the school setting, children diagnosed with ADHD may receive educational services in a number of different settings. It is common for children with ADHD to be placed in the general education classroom where they are provided with educational modifications that are required by Section 504 of the Rehabilitation Act. Such accommodations might include modification of homework, instruction, and testing procedures. In addition, the child might be able to use aids such as tape recorders. Teachers commonly use behavior modification techniques to improve behavior and academic performance in the classroom. Such techniques might include the use of positive consequences (e.g., praise, positive reinforcers) for appropriate behavior and negative consequences (e.g., time out) for inappropriate behavior. Alternatively, students with ADHD might receive special education services under the Other Health Impaired category defined in the Individuals with Disabilities Education Act (IDEA) or the LD category if they have been determined to have a comorbid LD. IDEA provides federal funding to assist states in meeting the educational needs of students with disabilities. IDEA provides each student with an Individual Education Plan and placement in a smaller special education setting (Davilla, Williams, & MacDonald, 1991). Both Section 504 of the Rehabilitation Act and IDEA ensure that students will receive services to help with their special needs (IDEA, 20 U.S.C. 1400 (c)); however, many children with ADHD receive neither 504 nor IDEA Services. Children with ADHD and a comorbid learning disability would most likely receive IDEA services. Children with ADHD who do not have a diagnosis of a learning disability would most likely receive 504 services or services under the Other Health Impaired category of IDEA.

As many as 40% of children with ADHD receive special education services by the time they are adolescents, up to 35% of children with ADHD are retained at least once, 10-25% of children with ADHD have been expelled, and between 10-35% of children with ADHD never complete high school (Fischer et al., 1990, Weiss &

Hechtman, 1993). These disturbing statistics describing the academic achievement within the ADHD population warrant the need for research that will lead to interventions to increase the academic achievement of children with ADHD.

Theories of ADHD

Barkley's Theory of ADHD

Thus far, research investigating ADHD has in general been atheoretical. Studies have primarily been descriptive and exploratory in nature. Barkley (1997a, 1997b) proposed deficits in attention often displayed by children with ADHD are likely a secondary problem to deficits in behavioral inhibition. Behavior inhibition involves difficulties in self-regulation of behavior. Specifically, Barkley (1997a, 1997b) suggests children with ADHD have difficulty with stopping habitual (prepotent) responses, ongoing responses, and are easily disrupted by competing events that interfere with ongoing mental activities. Additionally, the theory posits deficits in executive functions might be a biproduct of poor response inhibition. Barkley's (1997a) model of ADHD postulates the lack of behavioral inhibition results in specific deficits in the four following executive functions: working memory; self-regulation of affect, motivation, and arousal; internalization of speech; and reconstitution.

Working memory involves mental processes such as the encoding and retrieval of information in addition to manipulating and acting on information. Both children and adults with ADHD show deficiencies on tasks measuring working memory processes such as the ability to solve arithmetic problems received auditorily, or retain and repeat a sequence of numbers in the reverse order in which the numbers were auditorily received (Barkley, Murphy, & Kwasnik, 1996; Mariani & Barkley, 1997). Deficits in self-regulation of affect/motivation arousal can result in difficulties with behaviors such as perspective taking, motivation to achieve long-term goals, and deficits in emotional self-control. Impairments in persistence in effort on tasks and poor peer relationships seen in some children with ADHD have been cited as evidence for deficits in self-regulation of affect/motivation (Barber, Milich, & Welsh, 1996; Barkley, 1990, 1997a). Deficits in internalization of speech are hypothesized to affect the ability to use self-directed speech, problem-solving abilities, ability to form internal rules to help guide behavior, and behaviors including self-reflection, questioning, and instruction (Barkley, 1997a). Research has indicated children with ADHD are late to develop the skill of internal speech and often use immature internal speech (Berk & Potts, 1991). Deficits in reconstitution are manifested as difficulties creating novel and complex behavioral sequences in order to attain future goals in addition to tasks requiring the skills of analysis and synthesis. Research has shown children with ADHD to include less information and organization than children without ADHD in story-formation tasks (Tannock, Purvis, & Schachar, 1992). The combination of problems with behavioral inhibition and deficits with executive functioning leads to observable impairments of control, persistence, flexibility, and goal-directed behavior (Barkley, 1997a).

Treatment implications based on Barkley's (1997a) theory of ADHD would suggest the need for environmental modifications in order to maximize desired behaviors and minimize undesired behaviors. Specifically, techniques such as breaking tasks into smaller components and providing consequences (e.g., rewards) for appropriate behavior temporally close to when the behavior occurs might be used to target deficits in self-regulation of motivation and reconstitution. Providing prompts to help guide rule-governed behavior might target deficits in internalization of speech, and minimizing environmental distractions might allow more availability of working memory sources for the task at hand.

Environmental Setting

For many years ecological psychologists have recognized the potential importance of the environmental setting of the classroom in relation to academic performance (Jerison, 1959; Joiner & Kottmeyer, 1971). Research in this area has focused on environmental variables, including visual stimulation such as lighting (Fletcher, 1983; Ott, 1976) and auditory stimulation (Bronzaft & McCarthy, 1975; Cohen et al., 1980; Jerison; Joiner & Kottmeyer; Spradlin et al., 1959).

Much of the research examining the effects of visual stimulation on behavior and academic performance has looked at three different factors: lighting, peripheral stimulation (visual stimuli that are not part of the task at hand), and within-task stimulation (visual stimuli that are part of the task being monitored). In general, cool white fluorescent lighting is associated with an increase in off-task behavior in both children with hyperactivity and children without hyperactivity, while daylight fluorescent lighting is associated with increased attention and less hyperactive behavior (Coleman, Frankel, Ritvo, & Freeman, 1976; Fletcher, 1983). Children with hyperactivity often have increased attention problems under peripheral visual stimulation; however, the increase in attentional problems does not necessarily lead to performance deterioration (Gardner et al., 1959; Zentall, Barack, & Robin, 1978). Zentall and Kruczek's (1988) research indicated within-task stimulation might have more effect on academic performance than peripheral stimulation. General colors or stimulants added to a page improved academic performance and decreased problematic attentional behaviors. In general, the effect of increased visual stimulation has been associated with a decrease in hyperactive behavior and improvement in academic performance (Forehand & Baumeister, 1970; Gardner et al.; Tizard, 1968).

The effects of increased auditory stimulation on activity of children with hyperactivity has also been associated with decreased hyperactive behavior, although somewhat less consistently. Results in this area have elicited two main but conflicting theories about the effects of noise on the academic performance of children who exhibit ADHD behaviors. One theory suggests that children who exhibit ADHD behaviors are overstimulated and decreased auditory stimulation results in better academic performance (Cruickshank et al., 1961; Strauss & Lehtinen, 1947). The second theory suggests children who exhibit ADHD behaviors are underaroused, therefore, concluding the presence of environmental noise causes increased academic performance (Zentall & Zentall, 1976). These theories are discussed in more detail in the following sections.

The Stimulus Reduction Theory

Strauss and Lehtinen (1947) proposed children with hyperactivity suffered from a form of brain damage that prohibited them from sufficiently filtering out irrelevant stimuli. In addition, Strauss's theoretical framework suggested the children with hyperactivity were unable to adequately organize relevant stimuli. The combination of the inability to filter out and organize information creates overstimulation, which leads to increased activity. Strauss's theory also proposed that the inability to organize stimuli resulted in disorganization.

Strauss and Lehtinen's (1947) theory is derived from three main assumptions: (a) all hyperactive children have brain injuries; (b) hyperactive children have brain injuries that impair their ability to filter out irrelevant stimuli; and (c) the inability to filter out irrelevant stimuli results in behaviors such as hyperactivity and distractibility. Based on the second and third assumptions (the inability to filter out important stimuli, resulting in hyperactive and distractable behaviors), Strauss and Lehtinen proposed a treatment for ADHD that involved the maximal reduction of environmental stimuli. Cruickshank and colleagues (1961) applied Strauss and Lehtinen's theoretical framework to treat children with hyperactivity in the educational setting. Children with hyperactivity were tracked over a year-long longitudinal study in environments with normal stimulation and environments with reduced stimulation. The reduced stimulation environment was described as follows:

> It is suggested that one feature of an appropriate learning environment for distractible children is a classroom as devoid of stimuli as possible. The color of the walls, woodwork, and furniture should match the floor; windows should be made opaque; bulletin boards and pictures should be removed; inter-communication systems should be disconnected and pencil sharpeners removed; ceiling and walls near halls be sound-treated so as to absorb external noise; all furniture should be removed except that which is absolutely essential to teaching program...the concept of reduction of environmental stimuli must be seriously considered, and every possible unessential stimulus in the classroom must be removed or reduced in its visual, auditory, or tactual impressiveness.... It is therefore suggested that cubicles three feet square be constructed for each child. (Cruickshank et al., 1961, p. 131)

Overall, the results of the study did not support the use of reduced stimulation to increase academic performance and decrease inappropriate behavior. Only seven of the 64 statistical tests ran were statistically significant. One of the seven significant tests indicated a loss for the experimental group; the other six were related to gains on the Bender-Gestalt test. Although the bulk of the data did not support the use of stimulus reduction, the authors concluded stimulus reduction was an effective treatment.

The stimulus reduction theory proposed that hyperactive behavior occured when environmental stimulation exceeds the child's ability to process it, indicating hyperactive behavior serves no function for the child and is a random, uncontrolled, and undirected response to the overstimulation. Although there has been little empirical support for the stimulus reduction theory, treatment programs and educators have adopted the theory. For example, teachers have used methods such as having children wear headphones to limit auditory distractions (Alabiso, 1972; Kirk, 1972; Wasserman, Asch, & Snyder, 1972).

Optimal Stimulation Theory

Since the stimulation reduction was first developed, an alternative model has been proposed that suggests individuals have an optimal level of stimulation that is biologically predetermined. Fluctuations in the environmental stimulation will result in fluctuations in the amount of hyperactive behavior displayed. The optimal stimulation theory has yielded more empirical support than the Stimulus reduction model. The support for the optimal stimulation theory has changed the way many researchers conceptualize ADHD, suggesting the child with ADHD is understimulated rather than overstimulated.

The optimal stimulation theory purposes increased environmental stimulation decreases hyperactivity rather than increases hyperactivity. Support for the this model includes numerous observations of hyperactive children, which show that they cannot be differentiated from normal children in high stimulation environments such as the playground, movies, novel environments, and games (Cruickshank, Junkala, & Paul, 1968; Kaspar, Millichap, Backus, & Schulman, 1971; Stewart, 1970; Strauss & Lehtinen, 1947; Zentall, 1975; Zuk, 1963). In low stimulation environments, children with hyperactivity show more hyperactive behaviors and are distinguishable from the other children (Zentall, 1975).

Researchers suggest each individual has an optimal level of needed stimulation in a given environment that is controlled by a homeostatic control mechanism that helps keep environmental stimulation at this optimal level. Hyperactive behavior might increase stimulation in environments where stimulation is insufficient (Berlyne, 1960; Forehand & Baumeister, 1970; Leuba, 1955). Zentall (1977) suggested hyperactive behaviors (e.g., head and eye movement, increased motor activity, verbalizations) all serve as needed stimulus input for optimal stimulation. Thus, hyperactive behavior is purposeful and functions to optimize the amount of stimulation input. The child will show increases of hyperactive behavior in an environment that lacks sufficient amounts of stimulation and decreases in hyperactive behavior in environments where there is excessive stimulation.

Studies that have manipulated environmental visual and auditory stimuli have supported the optimal stimulation model. Zentall and Zentall (1976) found children with hyperactivity showed significantly less activity and improved academic performance and behavior (although results did not reach significance) in high stimulation environments (walls had bright wall hangings and decorations, bright colored carpet, Christmas lights, bright lighting, and rock music in the background) versus low stimulation environments (white walls, grey flooring, dimmer lighting, and continuous white noise in the background). Other studies have also found hyperactive behaviors to decrease as the amount of sensory stimulation increases (Cleland, 1962; Forehand & Baumeister, 1970; Gardner et al., 1959; Reardon & Bell, 1970; Tizard, 1968). Research has indicated that different types of auditory stimulation have different effects on behavior and academic performance. Zentall and Shaw (1980) concluded that auditory linguistic stimulation (i.e., conversation) is more likely to be distracting than nonlinguistic stimulation. They found children who were mentally retarded and had hyperactivity showed less activity in the presence of meaningful stimuli (i.e., music and voices) during the absence of any task requirements (Zentall & Shaw). Children with hyperactivity have also been shown to increase math productivity in the presence of rock and roll music compared to the normal classroom stimulation. In one study, 30% of children with ADHD showed an increase in math productivity when listening to rock and roll music, but there was no effect for music in children without ADHD (Pelham et al., 1993). In another study, children with ADHD improved correct responding to math problems in a music condition (rock and roll and rap music) by 33%, compared to a condition with background speech, and 23% compared to a noise condition (Abikoff et al., 1996). These researchers concluded music that was appealing and highly salient had a facilitative effect on academic performance.

Increases in nonmeaningful stimuli (e.g., white noise and speeded language) have been shown to have little effect on hyperactive behavior (Levitt & Kaufman, 1965; Spradlin et al., 1959; Steinschneider et al., 1966). In the absence of any task requirements, high levels of white noise have been found to increase activity in children without hyperactivity and children with mental retardation (Levitt & Kaufman; Steinschneider et al.).

Additional support for the optimal stimulation theory is provided by research related to the relationship between task novelty and activity. When stimuli that typically act as antecedents to hyperactive behavior were introduced in novel environments (which one would assume are more stimulating than nonnovel environments), children with hyperactivity showed no differences in activity level compared to normal children (Stewart, 1970). Cohen and Douglas (1972) found hyperactive behavior increased as exposure time to a novel task or novel environment increased, regardless of the quality of the child's performance. Additionally, both children with hyperactivity and without hyperactivity showed an increase in activity across trials that required the children to listen to tones; however, the hyperactive group showed significantly greater increases in activity (Cohen & Douglas). Similarly, in an auditory stimulation experiment that extended over a 4-day period, Reardon and Bell (1970) attributed the increase in activity on days 3 and 4 to decrease in novelty of the auditory stimulation. Tizard (1968) found mentally retarded children with hyperactivity showed fewer hyperactive behaviors in novel situations and increased activity as adaptation to the novel situation occurred. Opposite to these children, the control group children showed more initial activity with the initial exposure and decreased activity with adaptation. Findings such as these that show an increase in exposure to a task accompanied by an increase in hyperactive behavior offer support for the idea that novel situations are highly stimulating and require less hyperactive behavior to maintain an optimal level of stimulation. However, as the child habituates to the situation, the situation becomes less stimulating and more hyperactive behavior is needed to maintain an optimal level of stimulation.

Purpose and Objectives

Research suggests many factors play a role in the effects that various auditory stimulation have on the behavior and academic performance of children with ADHD. Such factors include: individual differences in stimulation needs, type of noise, task difficulty and task requirements, and exposure time to the task. The multitude of factors involved in assessing the effects of auditory stimulation on behavior and academic performance make it difficult to study.

Many argue that children with ADHD symptoms are overstimulated by sensory stimuli due to their inability to filter irrelevant material, thus indicating the need to reduce environmental stimulation (Cruickshank et al., 1961; Strauss & Lehtinen, 1947). Although little empirical support exists to support this overarousal theory, reduction of classroom stimulation has been a common practice in treating children with hyperactivity (Campbell et al., 1971; Carter & Diaz, 1971; Cruickshank et al., 1961; Rost & Charles, 1967; Scott, 1970). Others argue for the optimal stimulation theory, which suggests children with ADHD are underaroused and seek extra environmental stimulation in order to maintain an optimal level of needed stimulation (Berlyne, 1960; Forehand & Baumeister, 1970; Leuba, 1955).

The purpose of the current study was to evaluate the effects of various auditory stimuli on the behavior and academic performance of children with and without ADHD. Specifically, academic performance of both children with and without ADHD was assessed under four noise conditions: no noise, typical classroom noise, typical classroom noise with linguistic conversation, and typical classroom noise with background music containing no lyrics. The study attempted to (a) clarify the effects of various types of noise on the academic performance of children with and without ADHD, (b) distinguish how noise differentially affects children with ADHD compared to children without ADHD, (c) clarify the effects of noise on the behavior of children with and without ADHD while completing academic tasks, and (d) distinguish how noise differentially affects the behavior of children with and without ADHD while completing academic tasks.

Specifically, this study attempted to answer the following questions:

1. What effect does noise have on the mathematical performance of children with ADHD and without ADHD?

2. Are there differences in mathematical performance based on the type of noise presented?

3. Does the presence and/or the type of noise differentially affect children with ADHD compared to children without ADHD?

4. What effect does noise have on the behavior of children with and without ADHD while completing an academic task?

5. Are there differences in behavior based on the type of noise presented?

6. Does the presence and/or the type of noise differentially affect the behavior

of children with ADHD compared to the children without ADHD?

The current study aimed to test two differing theories of the nature of ADHD: The stimulus reduction theory and the optimal stimulation theory. The stimulation reduction theory postulates that observable hyperactive behavior is an undirected and uncontrolled response to environmental stimulation that exceeds an individual's ability to process. Based on this theory, one would hypothesize both children with and without ADHD would work best in quiet noise-free environments. Additionally, the stimulation reduction theory would indicate both children with ADHD and children without ADHD would exhibit fewer problem behaviors in environments with less external stimulation.

The optimal stimulation theory proposes hyperactive behavior is purposeful and functions to optimize the amount of stimulation input. The child will show increases in hyperactive behavior in an environment that lacks sufficient amounts of stimulation and decreases in hyperactive behavior in environments where there is excessive stimulation. Based on the optimal stimulation theory, children will perform better in environments containing external stimulation versus environments that are free from external environmental stimulation.

CHAPTER III

METHODS

Participants

A total of 33 children participated in the current research. Of the 33 participants, 15 children (11 male, 4 female; ages 6-12) had a formal diagnosis of ADHD, and 18 children (7 male, 11 female; ages 6-11) did not have a formal diagnosis of ADHD. The average age for the children with ADHD was 8.11 years (SD = 1.41) and the average age for the children without ADHD was 7.87 years (SD = 1.85). The average grade level for the children with ADHD was 2.33 (SD = 1.54) and the average grade level for the children without ADHD was 2.61(SD = 1.24). There were no significant differences between the ages, ($F(2) = .186$, $p = .669$) or the grade levels ($F(2) = .328$, $p = .571$) of children with ADHD and without ADHD. Thirty (91%) of the participants were Caucasian, two (6%) were Hispanic, and one (3%) was African American. One (6%) of the 15 children with ADHD received special education services for speech articulation problems, and no children in the group without ADHD received special education services. Eleven (73%) of the children with ADHD were taking psychostimulant medication to treat their symptoms of ADHD. All testing was completed after the effects of the medication wore off or prior to administration of the psychostimulant medication. See Table 1 for sample demographic information.

Instrumentation

Parents of all children in this study completed the Attention-Deficit/

Table 1

Demographic Information

	Children with ADHD (N = 15)		Children without ADHD (N =18)	
Variable	n	%	n	%
Gender				
Male	11	73	7	39
Female	4	27	11	61
Grade level				
1st	6	40	4	22
2nd	4	27	4	22
3rd	2	13	7	39
4th	0	0	1	6
5th	3	20	2	11
Take psychostimulant meds	11	73	0	0

Hyperactivity Disorder Symptoms Rating Scale (ADHD-SRS), a rating scale intended to help detect the presence of ADHD in children between the ages of 5-18 (grades k-12). The ADHD-SRS was used to ensure children with ADHD had significant symptoms of ADHD and children without ADHD did not have symptoms of ADHD. The ADHD-SRS consists of 56 items and contains two subscales: inattentive and hyperactive/impulsive. The instrument has satisfactory psychometric properties that include internal consistency and test-retest reliabilities above .90. The scale's structure is supported by factor analysis, correlations are high with previously established measures of ADHD, and children diagnosed with ADHD score significantly higher than those not diagnosed with ADHD (Holland, Gimpel, & Merrell, in press).

Parents of the participants verbally answered questions regarding demographic information. The demographic information gathered included: age, birthday, gender, ethnicity, ADHD status, medication status, and Special Education status. See Appendix

B for an example of the initial contact information form.

Mathematical Curriculum-Based Measures (CBM) were used as an outcome measure. Each mathematical CBM consisted of specific math skills including: addition problems with sums ranging between 1 and 5, 0 and 10, and 11 and 18; subtraction sheets with answers ranging between 1 and 5, and 0 and 9; multiplication facts that include multiplication of single digits, double digits without regrouping and double digits with regrouping; and sheets with division problems using dividends between 0 and 5, 6 and 9, and 0 through 9. Each child's score on the CBM represented the number of digits correctly answered. A student's performance can fall within a mastery, instructional, or frustrational range. At mastery levels, students are typically able to use the skill without hesitation whereas students who perform a skill within the instructional area are usually able to progress at an adequate rate when provided with typical classroom instruction. Students performing within a frustrational range often fail to succeed at an adequate rate when working at that level. For each child, different mathematical CBMs were administered prior to beginning the study procedures until math skills that fell within the instructional range were found. Therefore, although math skills being tested for each individual were different, task difficulty for each child was similar. It is important to note little systematic investigation has been done to establish the reliability and validity of mathematical CBM measures. However, numerous studies have used CBM measures for mathematics as outcome measures (Fuchs, Fuchs, Phillips, Hamlett, & Karns, 1995; Stoner, Carey, Idkeda, & Shinn, 1994). Sample CBM sheets are provided in Appendix C.

Observations of each child's behavior during individual academic work were conducted using the Restricted Academic Situation Coding Sheet (Barkley, 1990). The coding sheet was used primarily because it includes behaviors that are typical of children with ADHD and are often exhibited in a classroom setting when independent seatwork is required. The measure has been found to discriminate children with ADHD from children without ADHD (Breen, 1989). The coding sheet included the following behaviors: fidgeting, vocalizing, playing with objects, and out-of-seat behavior. Off-task behavior was defined as any interruption of the child's attention to the mathematical task to engage in some other behavior. An example of off-task behavior would be a child breaking eye contact with the mathematical problems. Fidgeting was defined as "any repetitive, purposeless motion of the legs, arm, hands, buttocks, or trunk" (Barkley, 1990, p. 338). In order for the behavior to be considered repetitive, the movements must have occurred at least twice in succession and have no identifiable purpose. Examples of fidgety behavior include shuffling of feet, tapping of feet, tapping a pencil, and swaying back and forth. Vocalizing included any vocal noise or verbalization by the child. Examples of vocalizations would include talking, whispering, singing, humming, clicking of teeth, and so forth. Playing with objects was defined as touching any object in the room besides the table, chair, math problems, and pencil. A child would be considered playing with an object if he/she touched the light switch, walls, or any other object in the room. Out-of-seat behavior was considered any instance in which the child's buttocks left contact with the chair. The behavioral dependent variable consisted of the total number of behaviors observed across the five categories. The coding sheet and the operational definitions for the behaviors coded are listed in Appendix D.

The Radio Shack Digital Sound Level Meter was used to determine the average sound level within the classroom setting while obtaining the recordings that were used in the experimental conditions. The decibel meter detects sound between the range of 50-126 dB. The instrument updates the average decibel level every second for a 3-minute time period. The average sound level was calculated using five, 3-minute sample averages. Results indicated the average sound level was 60 db. Similar sound levels were used during the various noise conditions.

Procedures

Children with ADHD were recruited from the Utah State University Psychology Community Clinic, an ongoing research study for families with children with ADHD, and three rural school districts located in Southeastern Idaho. Participants were recruited using flyers and through word of mouth. Contact information (phone numbers) were provided on flyers as to who to contact for further information about participating in the study. When individuals verbally expressed desire to participate in the research project to others, permission was obtained for the researchers to contact the participants via telephone (e.g., participants in the research study for families with ADHD would verbally agree to permit researchers from the current study to telephone them about possible participation in the study). When contact was initially made with the parents of the participants, questions about demographic information were verbally answered. If the child was taking a psychostimulant medication, a testing time was scheduled where the effects of the medication had worn off or a time was scheduled prior to administration of the psychostimulant medication.

The following were specific inclusion and exclusion criteria: *Inclusion criteria* (a) child must currently be in grades 1-5, (b) children in the ADHD group must have a *DSM-IV* diagnosis of ADHD and fall within the "high risk" category as indicated by the ADHD-SRS, and (c) children in the control group cannot have a formal diagnosis of ADHD and must fall within the "normal" or "low-risk" range on the ADHD-SRS; *Exclusion Criteria* (a) child suffers from any auditory impairment, (b) the child receives special education services for a learning disability, and (c) English is not the primary language of the child. This last criteria was in place in order to control for possible attentional differences that might occur between individuals who speak English versus individuals who do not speak English when listening to classroom noise with English verbalization in the background. No children were excluded from participating in study based on these criteria.

All testing was conducted at the Utah State University Community Psychology Clinic or in similar settings located within the school districts. Each participant was individually tested in an experimental room that contained a child's desk and chair. Informed consent was obtained from parents and assent was obtained from children when they presented for their appointment. A copy of the consent form can be found in Appendix E. Once consent was provided, parents completed the ADHD-SRS. In order to familiarize the children with the observer, the observer played with the child while the parent completed the ADHD-SRS. Following this, each child's instructional level for math skills was found using mathematical CBMs. For each child, different mathematical CBMs were administered until math skills that fell within the instructional range were found. After instructional level was determined, each child was tested under the four different noise conditions (described below) using math skill sheets that contained math skills that fell within the instructional range. Each testing period was 5 minutes in duration. All children were tested under No Noise condition first. The children were then tested under the remaining conditions in a randomly assigned order. After the second testing period, each child received a 5-minute break. Throughout the four 5-minute testing periods, a research assistant sat behind the child out of visual site and worked on independent seatwork. See Appendix F for the protocol of procedures used by researchers during the testing procedures.

The four different noise conditions included: No Noise (NN); Ordinary Meaningless Classroom Noise (CN); Ordinary Meaningless Classroom Noise combined with voices (VN); and Ordinary Meaningless Classroom Noise combined with Classical Music (MN). In the no auditory stimulation condition (NN), no noise was presented. This condition was used as a control condition. Ordinary classroom noises (e.g., books dropping, bells, doors closing, desks moving, and coughing) were recorded on audiotapes using sampling over time in actual classroom environments. The intensity of the noise varied in relationship to intensities as recorded in the actual classroom. The normal background classroom noise combined with voices (VN) consisted of the normal classroom noise and a conversation between a teacher and a student. The normal background classroom noise combined with music (MN) consisted of the normal classroom noise and music playing in the background. Classical music with no linguistics was chosen in order to help control for the effects lyrics versus no lyrics might have on attentional processes. Conditions were chosen based on results from previous research that suggest different types of auditory noises have different effects on behavior and academic performance (Levitt & Kaufman, 1965; Spradlin et al., 1959; Steinschneider et al., 1966; Whalen et al., 1979). Weinsten and Weinsten (1979) found typical classroom noise had no effect on reading comprehension tasks and standard reading test performance. Zentall and Shaw (1980) concluded that relatively meaningful stimuli (i.e., music, voices, classroom sounds) can reduce hyperactive behavior when there are no task requirements; however, these researchers concluded auditory linguistic stimulation is difficult to ignore and results in performance deficits in children with hyperactivity. Others have suggested background music can increase academic productivity and decrease hyperactive behaviors (Reardon & Bell, 1970; Scott, 1970).

All testing periods were videotaped. Data from one child was not included in the analyses because the videotape failed to record. At a later time, all behaviors during the testing periods were coded from the videotapes using the Restricted Academic Situations Coding Sheet (Barkley, 1990). A partial interval sampling procedure was used during which behaviors were recorded every 15 seconds for 5 minutes while the children completed the mathematical CBM. If the child exhibited any of the behaviors at any point in the 15-second interval, a tally was placed next to that behavior.

Prior to coding tapes, training sessions were held and focused on teaching the coders the definitions of behaviors. Interrater reliability was calculated using two trained coders on 25% (n = 7) of the observations using the videotapes of the children while performing the mathematical tasks under the various auditory stimuli. Interrater reliability was determined by dividing the total number of behaviors exhibited over the four testing conditions (i.e., the sum of agreements and disagreements) by the number total number of agreements. Overall, interrater agreement of child observations was 95%.

CHAPTER IV

RESULTS

In order to ensure children with ADHD were actually displaying higher levels of ADHD symptoms than children without ADHD, mean scores on the ADHD-SRS were compared. The mean ADHD-SRS score of the children with ADHD ($M = 69.20$, $SD = 4.84$) was significantly higher, $F(2) = 109.92, p < .01$, than to the mean score of the children without ADHD ($M = 42.39$, $SD = 4.22$)

Academic Performance

Children's math performance across the four auditory stimulation conditions were analyzed via a 2 x 4 (group/ADHD status x auditory stimulation condition) repeated measures analysis of variance, with number of digits correct as the dependent variable. There was not a main effect for group. Results indicated no significant differences in math performance between children with ADHD and children without ADHD, $F(1, 31) = .721, p = .401$. The group by condition interaction was not significant, $F(3, 31) = .424, p = .736$, indicating the varying noise conditions effect both the children with and without ADHD the same. However, there was a main effect for auditory stimulation condition, $F(3, 31) = 4.69, p = .004$. Paired *t* tests were used in order to compare the number of digits correct between the different noise conditions. Results indicated children's performance based on number of digits correct was significantly better in the no-noise condition compared to the verbalization condition, $t(32) = 2.82, p = .008, ES = .17$, and the music noise condition, $t(32) =2.86, p = .007$, *ES* = .15. Although there were significant differences between the number of digits correct between the different noise conditions, the effect sizes for these differences were quite small. No significant differences in the number of digits correct were found between the digits correct in the no-noise condition compared to the classroom noise condition, $t(32)= 1.79$, $p = .083$, $ES = .09$, the classroom noise condition and verbal noise condition, $t(32) = 1.65$, $p = .110$, $ES = .08$, the classroom noise condition and the music noise condition, $t(32) = 1.21$, $p = .236$, $ES = .06$, and the verbal noise condition and music noise condition, $t(32) = -.534$, $p = .597$, $ES = -.02$. Table 2 presents the mean number of digits correct for both the children with ADHD and those without ADHD under the four auditory conditions.

Behavioral Performance

Children's behavior across the four auditory stimulation conditions were analyzed via a 2 x 4 (group/ADHD status x auditory stimulation condition) repeated measures analysis of variance with behavior as the dependent variable. Observations of each child's behavior during individual academic work were conducted using the Restricted

Table 2

Mean Number of Digits Correct Under the Four Auditory Conditions

	No-noise condition		Classroom noise condition		Verbalization noise condition		Music noise condition	
Group	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
ADHD	91.93	58.30	83.33	60.48	79.13	61.15	81.00	57.82
No ADHD	105.39	60.56	102.89	60.55	97.94	58.16	98.56	56.72
Total sample	99.27	59.00	94.00	60.38	89.39	59.36	990.58	57.01

Academic Situation Coding Sheet (Barkley, 1990). The coding sheet included the following behaviors: fidgeting, vocalizing, playing with objects, and out-of-seat behavior, which were summed to create a total behavior score. There was a main effect for group. Results indicated significant differences in behavior between children with ADHD and children without ADHD, $F(1, 31) = 4.055, p = .053$.

Children with ADHD ($M = 68.27, SD = 44.31$) exhibited more problem behavior than the children without ADHD ($M = 39.83, SD = 37.08$). The group by condition interaction was not significant, $F(3,31) = 1.619, p = .190$, indicating the varying noise conditions effected both the children with and without ADHD the same. However, there was a main effect for auditory simulation condition, $F(3, 31) = 6.078, p = .001$. Paired *t* tests were used in order to compare the number of problem behaviors exhibited between the different noise conditions. Results indicated children exhibited significantly fewer problem behaviors in the in the no noise condition compared to the classroom noise condition, $t(32) = -3.48, p = .001, ES = -.32$; the verbalization condition, $t(32)= -3.69, p = .001, ES = -.41$; and the music noise condition, $t(32) = -2.54, p = .016, ES = -.31$. Although there were significant differences between the number of problem behaviors exhibited among the different noise conditions, these differences were relatively small effect sizes in magnitude.

No significant differences in the number of problem behaviors exhibited were found between the classroom noise condition and verbal noise condition, $t(32) = -1.29, p = .205, ES = -.11$; the classroom noise condition and the music noise condition, $t(32) = .086, p = .932, ES = .01$; and the verbal noise condition and music noise condition, $t(32) = 1.04, p = .308, ES = .12$. Table 3 presents the mean number of

Table 3

Mean Number of Problem Behaviors Exhibited Under the Four Auditory Conditions

	No-noise condition		Classroom noise condition		Verbalization noise condition		Music noise condition	
Group	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
ADHD	3.33	9.90	16.53	11.82	19.80	14.20	18.60	12.75
No ADHD	7.94	8.13	11.33	10.80	11.11	10.25	9.44	9.08
Total sample	10.39	9.24	13.70	11.40	15.06	12.78	13.61	11.68

problem behaviors exhibited for both the children with and without ADHD under the four auditory conditions.

Potential Order Effects

Based on results from the two previous analyses, the question arose as to whether the children's increase in digits correct and decrease in problem behaviors during the no noise condition was a function of the decreased auditory stimulation or possible order effects because the no noise condition was always presented first. Although it was impossible to fully examine order effects since the no-noise condition was always presented first, children's mathematical performance based on the order in which they received the auditory stimuli was analyzed via a one-way analysis of variance with digits correct as the dependent variable and order as the independent variable in order to analyze potential order effects. Results indicated significant effects for the digits correct based on order, $F(3,32) = 4.919$, $p = .003$. Paired sample *t* tests were conducted in order to follow up on significant effects. Results of the *t* tests indicated children completed more digits correct on the first math sheet compared to the second math sheet completed, $t(32) = 2.96$, $p = .006$, $ES = .12$. Children also completed more digits correctly on the first math sheet compared to the third math sheet, $t(32) = 3.114$, $p = .004$, $ES = .19$. Children performed significantly better on the fourth math skills sheet compared to the third math skills sheet, $t(32) = -2.943$, $p = .006$, $ES = .01$. Although there were significant differences between the digits correct based on order, the effect sizes show these differences were very small in magnitude. See Table 4 for mean digits completed for each order.

To examine order effects for behavior, children's behavior based on the order in which they completed the mathematical skills sheets under the various auditory stimulation conditions was analyzed via a one-way analysis of variance with behavior as the dependent variable and order as the independent variable. Results indicated significant effects for the behaviors exhibited based on order, $F(3,32) = 7.268$, $p < .001$. Paired sample *t* tests were conducted in order to follow up on significant effects.

Table 4

Mean Number of Digits Correct Based on the Order Completed

	Digits correct	
Order	Mean	*SD*
1	99.27	59.00
2	92.09	58.33
3	88.30	58.59
4	93.58	59.84

Results of *t* tests indicated children exhibited fewer behavior problems during the math skills sheet completed first compared to the second, $t(32) = -2.803, p = .009$, $ES = -.24$; third, $t(32) = -3.447, p = .002$, $ES = -.44$; and fourth, $t(32) = -3.59, p = .001$, $ES = -.33$ math skills sheet. Although there were significant differences between the number of problem behaviors exhibited based on order, the magnitude of these differences was relatively small. See Table 5 for mean behavior problems for each order.

Correlations

To investigate the relationship between the number of digits correct and the number of problem behaviors exhibited in each of four varying noise conditions, Pearson correlation coefficients were calculated. The results of these analyses are presented in Table 6. Analyses indicated negative correlations between digits correct and problem behaviors exhibited in all conditions, indicating children's performance on the math problems improved as the number of problem behaviors decreased.

Table 5

Mean Number of Problem Behaviors Exhibited

Based on the Order Completed

	Problem behaviors	
Order	Mean	*SD*
1	10.39	9.24
2	12.82	10.23
3	15.64	13.67
4	13.91	11.64

Table 6

Correlations Between Digits Correct and Behavior Exhibited in the Various Auditory Conditions

Condition	Correlation
No noise	-.571[a]
Classroom noise	-643[a]
Verbal noise	-.538[a]
Music noise	-.581[a]

[a] Correlation is significant at the 0.01 level

CHAPTER V

DISCUSSION

Children with ADHD often have difficulties in academic situations. A substantial portion of children with ADHD have formally diagnosed learning disabilities, but even those without a comorbid diagnosis often underachieve in academic situations. Children with ADHD often have a low-level mastery of academic material and are not productive in completing their schoolwork. Additionally, off-task behaviors (e.g., out of seat, lack of attention to academic materials) can further interfere with effective learning for these children. Given these difficulties, it is important to investigate strategies that will improve the academic performance and classroom behavior of children with ADHD. Environmental manipulations (e.g., variations in noise, lighting) have been hypothesized to affect the academic performance and classroom behavior of children with ADHD; however, empirical data is scarce and there is a lack of consensus regarding the effects of such manipulations. The purpose of this study was to evaluate the relationship between different types of background noise and the academic performance and behavior of children with ADHD, as well as a comparison group of children without ADHD.

The academic performance and behaviors of each child were evaluated in an analogue classroom situation under four different noise conditions, each 5 minutes in duration: no noise, standard classroom noise (e.g., classroom recordings that included sounds such as books dropping, doors closing, desks moving, and coughing), standard classroom noise with verbalizations in the background (e.g., classroom recordings that included the classroom noise and a conversation between a teacher and a student), and classroom noise with classical music containing no linguistics in the background (e.g., the normal background classroom noise with classical music). Conditions were chosen based on previous research findings that suggest different types of auditory noises (e.g., meaningful stimuli such as voices versus background music) have different effects on behavior and performance.

Each participant was given a sheet with math problems to complete that was at that participant's instructional range as determined by a curriculum-based academic probe. All sessions were videotaped and at a later time, behaviors during the testing periods were coded using a partial interval sampling procedure. Behaviors coded included fidgeting, vocalizing, playing with objects, and out-of-seat behavior.

Overall, children with ADHD performed as well on the math problems as children without ADHD. This finding is somewhat surprising given that researchers have indicated children with ADHD often have difficulty within the academic setting compared to children without ADHD. Children with ADHD often view tasks that require sustained attention and persistence as aversive and often have difficulty completing assignments (Barkley, DuPaul, & McMurray, 1990). A variety of reasons might account for the similarity in the number of digits correct for the children with and without ADHD. The setting in which the participants completed the math sheets differed significantly from most academic settings. The novelty of the setting in addition to the lack of external distraction (i.e., peers) might account for similarities in academic performance between children with and without ADHD. Children were also presented with a reward at the end of the testing periods, and the anticipation of receiving a reward for good effort might have accounted for similarities in performance. Another explanation for similarities in scores might be similar preferences between the groups for mathematical problems. Also, all children performed math problems at their individual instructional level, so children who typically have academic difficulties might not have found the math problems aversive.

Second, the results suggest both children with and without ADHD perform better in environments consisting of few- to no-auditory stimuli. Overall, both children with and without ADHD performed better on the mathematical tasks when little- to no-background noise stimulation was present. The number of digits correct were similar in the no noise condition and the classroom noise condition; however, significant differences were detected between the no-noise condition and both the verbalization and music conditions. Such results do not lend support to the optimal stimulation theory, which posits children with ADHD are underaroused and seek out stimulation to help reach an optimal level (Cruickshank et al., 1968; Strauss & Lehtinen, 1947; Zentall, 1975, 1977). The optimal stimulation theory would posit more stimulation would help children with ADHD reach an optimal or more normal level of simulation. Such findings might be explained by the methodology of the experimental design, which are discussed later in the paper.

Other research (Abikoff et al., 1996) has showed children with ADHD perform better when performing mathematical problems while music was playing. Such research allowed the children to choose the music to listen to while performing math problems. The researchers attributed the improved performance to the appealing, salient stimulation of the music. The researchers indicated the appeal of the stimulation might be more important than the presence of the simulation. The current results do not support this hypothesis given both children with ADHD and children without ADHD performed best with no background stimulation. However, all research participants were subjected to the same music condition and had no input on the type of music to which they were exposed. Differences in the present results compared to the results of Abikoff et al. might potentially be due to the salience and preference for the music chosen when given the option.

Children with ADHD exhibited more problem behaviors when completing the math skills sheets than children without ADHD. Based on the criteria delineated in *DSM-IV-TR* (APA, 2000), one would expect children with ADHD to inherently exhibit more problem behaviors than an individual without ADHD. Children with ADHD also had significantly higher scores on the ADHD-SRS compared to children without ADHD, adding more support that the children with ADHD show significant ADHD symptoms. In addition, the coding sheet chosen consisted of behaviors that are typical of children with ADHD (i.e., fidgeting, off-task behavior, out-of-seat behavior, playing with objects, and vocalizing) and are often exhibited in a classroom setting when independent seatwork is required. The measure has been found to discriminate children with ADHD from children without ADHD (Breen, 1989). Observations of children with ADHD in the classroom and during individual task work often show them to exhibit the following behaviors: out-of-seat behavior, restless and fidgety movements of their limbs while working, unusual vocal noises, talking out of turn, and playing with objects not related to the task at hand (Barkley, DuPaul, & McMurray, 1990; Fischer et al., 1990; Zentall, 1975). Thus, these results are not surprising and are consistent with the descriptive criteria used to make a diagnosis of ADHD, as well as the research suggesting children with ADHD exhibit more problem behaviors during independent task work.

Results showed a nonsignificant noise x group interaction, meaning the various auditory stimulation conditions did not impact the number of problem behaviors exhibited by the children with ADHD any differently than the children without ADHD; however, significant differences were detected between the various noise conditions. Children showed significantly fewer problem behaviors when performing math problems in the no-noise condition compared to the classroom noise condition, verbalization condition, and music condition. As with the results for mathematical performance, these results support the stimulus reduction theory and indicate increases in the presence of external auditory stimulation increases the amount of problem behaviors exhibited by both children with and without ADHD. Such results oppose the underarrousal theory, which indicates children with ADHD are underaroused, meaning they would engage in more hyperactive behavior in low stimulation environments in order to reach a more normal level of stimulation.

Although there were significant differences between the digits correct and the number of problem behaviors exhibited based on the auditory stimulation condition in which the math sheets were completed, the effect sizes show these differences were quite small in magnitude. This would indicate the change in background stimulation has some impact on academic performance and behavior; however, given the minimal impact, implications for intervention might warrant the use of reduction in external auditory stimulation in combination with other interventions (e.g., breaking class assignments into small sections, frequent reinforcement), which have proven to be effective in improving academic and behavioral functioning in children with ADHD (Davilla et al., 1991).

Unexpected order effects were detected for both the number of digits correctly answered and behaviors exhibited based on the order the children performed the math task. Order effects for the number of digits correct revealed children performed significantly better on the initial math task performed compared to the second and third math tasks, in addition to performing significantly better on the fourth math task compared to the third math task. Order effects for the number of problem behaviors exhibited revealed children exhibited fewer behavior problems during the math skills sheet completed first compared to the second, third, and fourth math skills sheets. Although there were significant differences between the digits correct and the number of problem behaviors exhibited based on the order that the math sheets were completed, the effect sizes show these differences were quite small in magnitude. This would indicate although the order the math sheets were completed might have had some effect on academic and behavioral performance, this effect is very small.

All participants completed the initial math sheet in the no-noise condition and then completed math sheets under the classroom noise, verbal noise, and music noise conditions based on random assignment. Because the design of the study did not control for possible order effects with the no-noise condition, it is impossible to determine if improved performance and behavior during the no noise condition was due to a decrease in the environmental auditory stimulation or due to possible initial performance effects. Two possible explanations might be used to explain these findings. Results might support the stimulus reduction theory, suggesting children's performance and behavior improve in environments low in auditory stimulation. Another explanation might be children performed better in the no-noise condition because of order effects. Previous research has indicated children with ADHD often show improved academic performance and fewer problem behaviors in novel environments and on novel tasks (Cohen & Douglas, 1972; Reardon & Bell, 1970; Stewart, 1970). This explanation of the findings would add support for the optimal stimulation theory, suggesting novel environments and novel tasks are more stimulating and require less hyperactive behavior in order to maintain an optimal level of stimulation. It is important to note that prior to completing math skills sheets in the No Noise condition, all individuals completed 1-minute mathematical curriculum-based probes in order to determine instructional level. Due to this prior exposure, the environment and the math skills sheets in the no-noise condition were not entirely novel. This might suggest the relatively higher level of academic performance and lower level of problem behaviors in the no noise condition cannot entirely be attributed to the novelty of the task and environment.

Pearson *R* correlation coefficients consistently yielded significant negative relationships between the number of digits correct in a given condition and the number of problem behaviors exhibited in the same condition. Such results indicate a consistent pattern where children's performance improved as the number of problem behavior's exhibited decreased. Such findings suggest the presence of those problem behaviors (fidgeting, off-task, out of seat, vocalizing, and playing with objects) negatively impact academic performance. These results would be expected given the problem behaviors would inhibit the child's ability to perform math tasks.

Several limitations in the present study should be considered when evaluating the results of the current study and in the design of future research looking at the effects of environmental stimulation in the future. As discussed earlier, the design of the current study did not control for possible order effects. All participants completed the first math task in the no noise condition. The original rationale for this design was to gain a baseline measure of math performance and behavior. Due to the fact that the no noise condition was not counterbalanced, it is difficult to fully explain both children's better math performance and better behavior during the no noise condition; however, given there was not a consistent drop across the four testing sessions, it seems likely better performance in the initial session was not completely due to order. Future research should address this issue to help clarify whether the reduction in environmental auditory stimulation or the initial performance effects can account for the improved math performance and behavior. One potential way would be to get baseline performance using a no noise condition; however, each individual would perform math tasks in an additional no noise condition within a counterbalanced design with another noise condition. Such a design would still provide a baseline measure and help delineate whether the reduction in auditory stimulation or the order of performing the math tasks are responsible for improved performance and behavior.

One aspect of this study that makes it difficult to compare results to those of previous studies is that the current study attempted to control for effects of task difficulty using CBMs. Previous research has included academic tasks where task difficulty level was not indicated or where task difficulty level was assumed to be near grade level. However, such research did not look for individual ability levels specific to the participants (Abikoff et al., 1996; Zentall & Shaw, 1980). Eysenck (1976) proposed an inverse relationship between the amounts of additional stimulation needed during tasks with varying difficulty. Some researchers have found increased environmental stimuli can interfere with performance on more difficult tasks (Broadbent, 1971; Hockey, 1970). Pope (1970) found children with ADHD exhibited similar behavior to children without ADHD on simple tasks, but exhibited more hyperactivity on more difficult tasks. In this study, all children performed math problems that fell within their instructional range. Because task difficulty was the same for all children, the present study cannot evaluate how task difficulty affects academic performance. Future research in this area should incorporate tasks of differing difficulty levels. This could be done using CBM measures that include skill sheets falling within different difficulty ranges (e.g., tasks falling within the frustrational and mastery ranges). Varying difficulty levels might help to gain a better understanding of how auditory stimulation affects academic performance and behavior differently based on task difficulty. It would be expected that increases in task difficulty would lead to a decrease in academic performance, and an increase in problem behaviors with both children with and without ADHD, with a relatively larger impact on children with ADHD. A decrease in task difficulty might result in improved performance and a decrease in problem behaviors in children without ADHD. A decrease in task difficulty might result in an initial increase in academic achievement in the children with ADHD; however, it is expected these children might become bored with the task, which would eventually lead to a decline in academic achievement and an increase in problem behaviors.

Another potential limitation to this study is the verbal auditory condition used. The condition included audio recordings of a normal background classroom noise and a conversation between a teacher and a student. The conversation included information pertaining to sentence structure. Potentially, differences in the topic of the conversation between the teacher and the child on the audio recordings and the math task requirement performed by the participants in the study might affect academic performance and behavior differently than if the topic of the conversation and the task at hand involved similar skills. Furthermore, future research should also focus on the effects of various types of verbalization noises. The child's interest in the topic of conversation (e.g., sentence structure versus a popular television program) might impact the attention and focus on the conversation. For example, conversations about a topic of interest would likely be distracting to both children with and without ADHD, but relatively more distracting to children with ADHD. Researchers have investigated possible interference effects of competing stimuli on performance using selective attention tasks. Selective attention tasks require an individual to focus their attention to one of many simultaneously presented tasks (Hawkins & Presson, 1986). Researchers have been interested in an individual's ability to exclude competing stimuli in the environment. Research has supported the idea that some information about stimuli, even when instructed to ignore, gets processed. Specifically, in tasks where auditory attention is divided, individuals are sometimes able to identify the meaning of the unattended conversation in addition to recognition of characteristics such as gender of the speaker and if their name was mentioned in the unattended conversation (Hirst, 1986; Moray, 1959; Treisman, 1960; Wood & Cowan, 1995). Other research has focused on selective visual attention. The Stroop effect refers to the phenomenon that people take longer to name the color of a stimulus when it is used as the color of an incongruent color word (e.g., the word red written in green ink), than when it appears as a congruent color word (e.g., the word red is written in red ink). The phenomena illustrate selective attention because the time needed to name the color increases when competing stimuli (e.g., the meaning of the word) are present (Stroop, 1935). Future research manipulating the congruence and incongruence of topics discussed in the verbalization condition with the task at hand would be helpful in gaining a better understanding of possible effects varying content might have on academic performance and behavior.

It is important to recognize the small sample size used in the present study. Replications with larger sample sizes are needed to cross-validate the findings. Additionally, the generalizability of the current findings to the general population and/or an actual classroom setting is questionable. Participants performed math problems in an isolated, contrived setting. Audio recordings of an actual classroom environment were used in order to make the contrived setting similar to an actual classroom environment. However, it is recognized that the actual classroom setting differs significantly from the analogue testing environment. Further research is needed to clarify effects of auditory stimulation on academic performance and behavior in an actual classroom environment. Such research could help to clarify findings related to the effects of the various auditory stimulation on academic performance and behavior, in addition to determine if results from an analogous classroom setting such as the one used in the present study are generalizable to a regular classroom setting.

Last, and maybe of most importance, the majority of literature on ADHD thus far has been primarily descriptive and exploratory in nature. Few theories have been proposed or gained consensus about what leads children to engage in behaviors often seen in children with ADHD. The limited number and lack of consensus of a theory of ADHD makes it difficult to make sense of many of the recent research findings showing evidence of deficits in cognitive functioning and behavior. Future research should focus on development of theory to help gain a more thorough insight as to the etiological factors and deficits associated with ADHD.

REFERENCES

Abikoff, H., Courtney, M. E., Szeibel, P. J., & Koplewicz, H. S. (1996). The effects of auditory stimulation on the arithmetic performance of children with ADHD and nondisabled children. *Journal of Learning Disabilities, 29*(3), 238-246.

Abramowitz, A. J., Reid, M. J., & O'Toole, K. (1994, April). *The role of task timing in the treatment of ADHD.* Paper presented at the Association for Advancement of Behavior Therapy, San Diego, CA.

Alabiso, F. (1972). Inhibitory functions of attention in reducing hyperactive behavior. *American Journal of Mental Deficiency, 77,* 259-282.

Anastopoulos, A. D., Guevremont, D. C., Shelton, T. L., & DuPaul, J. J. (1992). Parenting stress among families of children with attention deficit hyperactivity disorder. *Journal of Abnormal Child Psychology, 20*(5), 503-520.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorder* (4th ed., text revision). Washington, DC: Author.

Barber, M. A., Milich, R., & Welsh, R. (1996). Effects of reinforcement schedule and task difficulty on the performance of attention deficit hyperactivity disordered and control boys. *Journal of Clinical Child Psychology, 25*(1), 66-76.

Barkley, R. A. (1977). A review of stimulant drug research with hyperactive children. *Journal of Child Psychology and Psychiatry, 18*(2), 137-165.

Barkley, R. A. (1988). Attention. In M. Tramontana & S. Hooper (Eds.), *Assessment issues in child neuropsychology* (pp. 145-176). New York: Plenum.

Barkley, R. A. (1990). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment.* New York: Guilford.

Barkley, R. A. (1996). Attention-deficit/hyperactivity disorder. In E. J. Mash & R. A. Barkley (Eds.), *Child psychopathology* (pp. 63-112). New York: Guilford.

Barkley, R. A. (1997a). *ADHD and the nature of self-control.* New York: Guilford.

Barkley, R. A. (1997b). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121,* 65-94.

Barkley, R. A. (1998). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment.* New York: Guilford.

Barkley, R. A., & Cunningham, C. E. (1979). Do stimulant drugs improve the academic performance of hyperkinetic children?: A review of outcome research. *Journal of Clinical Pediatrics, 17,* 85-92.

Barkley, R. A., DuPaul, G. J., & McMurray, M.B. (1990). A comprehensive evaluation of attention deficit disorder with and without hyperactivity. *Journal of Consulting and Clinical Psychology, 58*(6), 775-789.

Barkley, R. A., Fischer, M., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria: I. An 8-year prospective follow-up study. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*(4), 546-557.

Barkley, R. A., Guevremont, D., Anastopoulos, A., DuPaul, G., & Shelton, T. (1993). Driving related risks and outcomes of attention deficit hyperactivity disorders in adolescents and young adults: A 3- to 5-year follow-up survey. *Pediatrics, 92*(2), 212-218.

Barkley, R. A., Koplowitz, S., Anderson, T., & McMurray, M.B. (1997). Sense of time in children with ADHD: Effects of duration, distraction, and stimulant medication. *Journal of the International Neuropsychological Society, 3*(4), 359-369.

Barkley, R. A., Murphy, K. R., & Kwasnik, D. (1996). Psychological adjustment and adaptive impairments in young adults with ADHD. *Journal of Attention Disorders, 1*(1), 41-54.

Barkley, R. A., & Ullman, D. G. (1975). A comparison of objective measures of activity level and distractibility in hyperactive and nonhyperactive children. *Journal of Abnormal Child Psychology, 3*(3), 213-244.

Befera, M., & Barkley, R. A. (1984). Hyperactive and normal girls and boys: Mother-child interactions, parent psychiatric status, and child psychopathology. *Journal of Child Psychology and Psychiatry, 26*(2), 439-452.

Berylyn, D. (1960). *Conflict, arousal, and curiosity.* New York: McGraw-Hill.

Berk, L. E., & Potts, M. K. (1991). Development and functional significance of private speech among attention-deficit hyperactivity disorder and normal boys. *Journal of Abnormal Child Psychology, 19*(3), 357-377.

Biederman, J., Faraone, S. V., & Lapey, K. (1992). Comorbidity of diagnosis in attention-deficit hyperactivity disorder. In G. Weiss (Ed.), *Child and adolescent psychiatric clinics of North America: Attention-deficit hyperactivity disorder* (pp. 335-360). Philadelphia: Saunders.

Breen, M. J. (1989). ADHD girls and boys: An analysis of attentional, emotional, cognitive, and family variables. *Journal of Child Psychology and Psychiatry, 30*(5), 711-716.

Breen, M. J., & Barkley, R. A. (1988). Parenting stress with ADDH girls and boys. *Journal of Pediatric Psychology, 13*(2), 265-280.

Broadbent, D. E. (1971). *Decision and stress.* London: Academic.

Brock, S. W., & Knapp, P. K. (1996). Reading comprehension abilities of children with attention-deficit/hyperactivity disorder. *Journal of Attention Disorders, 1*(3), 173-186.

Bronzaft, A. L., & McCarthy, D. P. (1975). The effect of elevated train noise on reading ability. *Environment and Behavior, 7*(4), 517-527

Brown R. T., & Borden, K. A. (1986). Hyperactivity at adolescence: Some misconceptions and new directions. *Journal of Clinical Child Psychology, 15*(3), 194-209.

Browning, R. M. (1967). Hypo-responsiveness as a behavioral correlate of brain damage in children. *Psychological Reports, 20*(1), 251-259.

Campbell, S. B., Douglas, V. I., & Morganstern, G. (1971). Cognitive styles in hyperactive children and the effect of methylphenidate. *Journal of Child Psychology and Psychiatry, 12*(1), 55-67.

Cantwell, D. P., & Satterfield, J. H. (1978). The prevalence of academic underachievement in hyperactive children. *Journal of Pediatric Psychology, 3*(4), 168-171.

Carter, J. L., & Diaz, A. (1971). Effects of visual and auditory background on reading test performance. *Exceptional Children, 38*(1), 43-50.

Casey, J. E., Rourke, B. P., & Del Dotto, J. E. (1996). Learning disabilities in children with attention deficit disorder with and without hyperactivity. *Child Neuropsychology, 2*(2), 83-98.

Cleland, C. C. (1962). Severe retardation-program suggestions. *Training School Bulletin, 59*(2), 31-37.

Cohen, N. J., & Douglas, V. I. (1972). Characteristics of the orienting response in hyperactive and normal children. *Psychophysiology, 9*(2), 238-245.

Cohen, N. J., Weiss, G., & Minde, K. (1972). Cognitive styles in adolescents previously diagnosed as hyperactive. *Journal of Child Psychology and Psychiatry, 13*(3), 203-209.

Cohen, S., Evans, G. W., Krantz, D. S., & Stokols, D. (1980). Physiological, motivational, and cognitive effects of aircraft noise on children. *American Psychologist, 35*(3), 231-243.

Coie, J. D., Dodge, K. A., & Kupersmidt, J. (1990). Peer group behavior and social status. In S. R. Asher & J. D. Coie (Eds.), *Peer rejection in childhood* (pp. 17-59). New York: Cambridge University Press.

Colman, R., Frankel, F., Ritvo, E., & Freeman, B. (1976). The effects of fluorescent and incandescent illumination upon repetitive behavior in autistic children. *Journal of Autism and Childhood Schizophrenia, 6*(2), 157-162.

Corkum, P. V., & Siegel, L. S. (1993). Is the continuous performance task a valuable research tool for the use with children with attention-deficit-hyperactivity disorder? *Journal of Child Psychology and Psychiatry, 34*(7), 1217-1239.

Cruickshank, W. M., Bentzen, F. A., Ratzeburg, F. H., & Tannhauser, M. T. (1961). *A teaching method for brain-injured and hyperactive children: A demonstration pilot study.* Syracuse, NY: Syracuse University Press.

Cruickshank, W. M., Junkala, J. B., & Paul, J. L. (1968). *The preparation of teachers of the brain-injured and hyperactive children.* Syracuse, NY: Syracuse University Press.

Davilla, R. R., Williams, M. L., & MacDonald, J. T. (1991). *Memorandum to chief state school officers re: Clarification of policy to address the needs of children with attention deficit disorders within general and/or special education.* Washington, DC: U.S. Department of Education.

Douglas, V. I. (1972). Stop, look, and listen: The problem of sustained attention and impulse control in hyperactive and normal children. *Canadian Journal of Behavioral Science, 4*(4), 259-282.

Douglas, V. I. (1983). Attentional and cognitive problems. In M. Rutter (Ed.), *Developmental neuropsychiatry* (pp. 280-329). New York: Guilford.

Douglas, V. I., & Peters, K. G. (1978). Toward a clearer definition of the attentional deficit of hyperactive children. In G. S. Hale & M. Lewis (Eds.), *Attention and the development of cognitive skills* (pp. 173-248). New York: Plenum.

DuPaul, G. J., & Stoner, G. (1994). *ADHD in the schools: Assessment and intervention strategies.* New York: Guilford.

Ebaugh, F. G. (1923). Neuropsychiatric sequelae of acute epidemic encephalitis in children. *American Journal of Diseases of Children, 25,* 89-97.

Edelbrock, C. S., Costello, A. J., & Kessler, M. D. (1984). Empirical corroboration of attention deficit disorder. *Journal of the American Academy of Child Psychiatry, 23*(3), 285-290.

Eysenck, M. W. (1976). Arousal, learning, and memory. *Psychological Bulletin, 83*(3), 389-404.

Faraone, S. V., Biederman, J., Lehman, B., Keenan, K., Norman, D., Seidman, L. J., Kolodny, R., Kraus, I., Perrin, J., & Chen, W. (1993). Evidence for the independent familial transmission of attention deficit hyperactivity disorder and learning disabilities: Results from a family genetic study. *American Journal of Psychiatry, 150*(6), 891-895.

Farrington, D. P., Loeber, R., & Van Kammen, W. B. (1989). Long term criminal outcomes of hyperactivity-impulsivity-attention deficit and conduct problems in childhood. In L. N. Robins & M. R. Rutter (Eds.), *Straight and devious pathways to adulthood* (pp. 62-81). New York: Cambridge University Press.

Fischer, M., Barkley, R. A., Edelbrock, C. S., & Smallish, L. (1990). The adolescent outcome of hyperactive children diagnosed by research criteria, II; Academic, attentional, and neuropsychological status. *Journal of Consulting and Clinical Psychology, 58*(5), 580-588.

Fletcher, D. (1983). Effects of classroom lighting on the behavior of exceptional children. *Exceptional Education Quarterly, 4*(2), 75-89.

Forehand, R., & Baumeister, A. A. (1970). Effects of variations in auditory and visual stimulation on activity levels of severe mental retardates. *American Journal of Mental Deficiency, 74*(4), 470-474.

Fuchs, L. S., Fuchs, D., Phillips, N. B., Hamlett, C. L., & Karns, K. (1995). Acquisition and transfer effects of classwide peer-assisted learning strategies in mathematics for students with varying learning histories. *School Psychology Review, 24*(4), 604-620.

Gardner, W. I., Cromwell, R. L., & Foshee, J. G. (1959). Studies in activity level. II. Effects of distal visual stimulation in organics, familials, hyperactives. *American Journal of Mental Deficiency, 63,* 1028-1033.

Gaub, M., & Carlson, C. L. (1997). Gender differences in ADHD: A meta-analysis and critical review. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*(12), 1036-1045.

Gickling, E., & Thompson, V. P. (1985). A personal view of curriculum-based assessment. *Exceptional Children, 52*(3), 205-218.

Gittelman, R., Klein, D. F., & Feingold, I. (1983). Children with reading disorders: II. Effects of methylphenidate in combination with reading remediation. *Journal of Child Psychology and Psychiatry, 24*(2), 193-212.

Hawkins, H., & Presson, J. (1986). Auditory information processing. In K. R. Boff, L. Kaufman, & J. P. Thomas (Eds.). *Handbook of perception and human performance* (Vol. 2, pp. 26-1-26-64). New York: Wiley.

Hockey, G. R. J. (1970). Effects of loud noise on attentional selectivity. *Quarterly Joural of Experimental Psychology, 22*(1), 28-36.

Hirst, W. (1986). The psychology of attention. In J. E. LeDoux & W. Hirst (Eds.). *Mind and the brain* (pp. 105-141). Cambridge, England: Cambridge University Press.

Hohman, L. B. (1922). Post-encephalitic behavior disorders in children. *Johns Hopkins Hospital Bulletin, 33,* 372-375.

Holland, M. L., Gimpel, G. A., & Merrell, K. M. (in press). *The Attention Deficit Hyperactiivty Disorder Symptoms Rating Scale.* Wilmington, DE: Wide-Range.

Jerison, H. I. (1959). Effects of noise on human performance. *Journal of Applied Psychology, 43,* 96-101.

Joiner, L. M., & Kottmeyer, W. A. (1971). Effect of classroom noise on number identification by retarded children. *California Journal of Educational Research, 22*(4), 164-169.

Kaspar, J. C., Millichap, J. G., Backus, D. C., & Schulman, J. L. (1971). A study of the relationship between neurological evidence of brain damage in children and activity and distractability. *Journal of consulting and Clinical Psychology, 36*(3), 329-337.

Kirk, S. P. (1972). *Educating exceptional children.* Boston: Houghton Mifflin.

Knobel, M., Wolman, M. B., & Mason, E. (1959, September). Hyperkinesis and organicity in children. *Archives of General Psychology, 18,* 310-321.

Kottmeyer, W. A. (1971). Effect of classroom noise on number identification by retarded children. *California Journal of Educational Research, 22*(4), 164-169.

Lahey, B. B., Applegate, B, &. Barkley, R. A. (1994). DSM-IV field trials for oppositional defiant disorder and conduct disorder in children and adolescents. *American Journal of Psychiatry, 151*(8), 1163-1171.

Lahey, B. B., & Carlson, C. L. (1992). Validity of the diagnostic category of attention deficit disorder without hyperactivity: A review of the literature. In S. E. Shaywitz & B. A. Shaywitz (Eds.), *Attention deficit disorder comes of age: Toward the twenty-first century* (pp. 119-144). Austin, TX: Pro-Ed.

Last, C. G., Perrin, S., & Hersen, M. (1992). A prospective study of childhood anxiety disorders. *Journal of American Academy of Child and Adolescent Psychiatry, 31*(6), 1070-1076.

Last, C. G., Phillips, J. E., & Statfeld, A. (1987). Comorbidity among childhood anxiety disorders. *Journal of Nervous and Mental Disease, 175*(2), 103-112.

Leuba, C. (1955). Toward some integration of learning theories: The concept of optimal stimulation. *Psychological Reports, 1,* 27-33.

Levitt, H., & Kaufman, M. E. (1965). Sound induced drive and stereotyped behavior in mental defectives. *American Journal of Mental Deficiency, 69*(5), 729-734.

Lewinsohn, P. M., Hops, H., Roberts, R. E., Seeley, J. R., & Andrews, J. A. (1993). Adolescent psychopathology: I. Prevalence and incidence of depression and other DSM-III-R disorders in high school students. *Journal of Abnormal Psychology, 102*(4), 133-144.

Livingston, R. L., Dykman, R. A., & Ackerman, P. T. (1990). Psychiatric comorbidity and response to two doses of methylphenidate in children with attention deficit disorder. *Journal of Abnormal Child Psychology, 18*(5), 465-478.

Loeber, R. (1990). Development and risk factors of juvenile antisocial behavior and delinquency. *Clinical Psychology Review, 10*(1), 1-41.

Loeber, R., Brinthaupt, V. P., & Green, S. M. (1990). In R. J. McMahon & R. Peters (Eds.). *Behavior disorders of adolescence: Research, intervention, and policy in clinical and school settings* (pp. 39-61). New York: Plenum.

Loeber, R., Green, S. M., Lahey, B. B., Christ, M. A. G., & Frick, P. J. (1992). Developmental sequences in the age of onset of disruptive child behaviors. *Journal of Child and Family Studies, 1*(1), 21-41.

Mariani, M., & Barkley, R. A. (1997). Neuropsychological and academic functioning in preschool children with attention deficit hyperactivity disorder. *Developmental Neuropsychology, 13*(1), 111-129.

McGee, R., Feehan, M., Williams, S., Partridge, F., Silva, P. A., & Kelly, J. (1990). DSM-III disorders in a large sample of adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry, 29*(4), 611-619.

McGee, R., Williams, S., & Silva, P. A. (1984). Behavioral and developmental characteristics of aggressive, hyperactive, and aggressive-hyperactive boys. *Journal of the American Academy of Child and Adolescent Psychiatry, 23*(3), 270-279.

Milich, R., & Dodge, K. A. (1984). Social information processing in child psychiatric populations. *Journal of Abnormal Child Psychology, 12*(3), 471-490.

Mirsky, A. F. (1996). Disorders of attention: A neuropsychological perspective. In R. G. Lyon & N. A. Krasnegor (Eds.), *Attention, memory, and executive function* (pp. 71-96). Baltimore: Brookes.

Moray, N. (1959). Attention in dichotic listening: Affective cues and the influence of instructions. *Quarterly Journal of Experimental Psychology, 11,* 56-60.

Munir, K., Biederman, J., & Knee, D. (1987). Psychiatric comorbidity in patients with attention deficit disorder: A controlled study. *Journal of the American Academy of Child and Adolescent Psychiatry, 26*(6), 844-848.

Ott, J. N. (1976). Influence of fluorescent lights on hyperactivity and learning disabilities. *Journal of Learning Disabilities, 9*(7), 417-422.

Pelham W. E., Carlson, C., & Sams, S. E. (1993). Separate and combined effects of methylphidate and behavior modification on boys with attention-deficit hyperactivity disorder in the classroom. *Journal of Consulting Clinical Psychology, 61*(3), 506-515.

Pfiffner, L. J., & Barkley, R. A. (1990). Educational management. In R. A. Barkley, *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment* (pp. 498-539). New York: Guilford.

Pope, L. (1970). Motor activity in brain injured children. *American Journal of Orthopsychiatry, 40*(5), 783-793.

Porrino, L. J., Raporport, J. L., Behar, D., Sceery, W., Ismond, D. R., & Bunney, W. E. (1983). A naturalistic assessment of the motor activity of hyperactive boys; I. Comparison with normal controls. *Archives of General Psychiatry, 40*(6), 681-687.

Rapport, M. D., DuPaul, G. J., Stoner, G., & Jones, J. T. (1986). Comparing classroom and clinic measures of attention deficit disorder: Differential, idiosyncratic, and dose-response effects of methylphenidate. *Journal of Consulting and Clinical Psychology, 54*(3), 334-341.

Reardon, D. M., & Bell, G. (1970). Effects of sedative and stimulative music on activity levels of severely retarded boys. *American Journal of Mental Deficiency, 75*(2), 156-159.

Rosenthal, R. H., & Allen, T. W. (1980). Intratask distractability in hyperkinetic and nonhyperkinetic children. *Psychology Bulletin, 8*(2), 175-187.

Ross, D. M., & Ross, S. A. (1982). *Hyperactivity: Research, theory, and action.* New York: Wiley.

Rost, K. J., & Charles, D. C. (1967). Academic achievement of brain injured and hyperactive children in isolation. *Exceptional Children, 34*(2), 125-126.

Russo, M. F., & Biedel, D. C. (1994). Comorbity of childhood anxiety and externalizing disorders: Prevalence associated characteristics, and validation issues. *Clinical Psychology Review, 14*(3), 199-221.

Schachar, R. (1991). Childhood hyperactivity. *Journal of Child Psychology and Psychiatry, 32*(1), 155-191.

Scott, T. J. (1970). The use of music to reduce hyperactivity in children. *American Journal of Orthopsychiatry, 40*(4), 677-680.

Semrud-Clikeman, M., Biederman, J., Sprich-Buckminster, S., Lehman, B. K., Faraone, S. V., & Norman, D. (1992). Comorbitity between ADDH and learning disability: A review and report in a clinically referred sample. *Journal of the American Academy of Child and Adolescent Psychiatry, 31*(3), 439-448.

Shores, R. E., & Haubrich, P. A. (1969). Effect of cubicles in educating emotionally disturbed children. *Exceptional Children, 36*(1), 21-24.

Somerville, J. W., Warnberg, M. A., & Bost, D. E. (1973). Effects of cubicles versus increased stimulation on task performance by first-grade males perceived as distractible and nondistractible. *The Journal of Special Education, 7*(2), 169-185.

Spradlin, J. E., Cromwell, R. L., & Foshee, J. G. (1959). Studies in activity level. III. Effects of auditory stimulation in organics, familials, hyperactives, and hypoactives. *American Journal of Mental Deficiency, 64,* 754-757.

Steinkamp, M. W. (1980). Relationships between environmental distractions and task performance of hyperactive and normal children. *Journal of Learning Disabilities, 13*(4), 40-45.

Steinschneider, A., Lipton, E. L., & Richmond, J. B. (1966). Auditory sensitivity in the infant: Effect of intensity of cardiac and motor responsivity. *Child Development, 37*(2), 233-252.

Stewart, M. A. (1970). Hyperactive children. *Scientific American, 222,* 94-98.

Still, G. F. (1902). Some abnormal psychical condition in children. *Lancet, 1,* 1008-1012, 1077-1082, 1163-1168.

Stoner, G., Carey, S. P., Ikeda, M. J., & Shinn, M. R. (1994). The utility of curriculum-based measurement for evaluating the effects of methylphenidate on academic performance. *Journal of Applied Behavior Analysis, 27*(1), 101-113.

Strauss, A. A., & Lehtinen, L. E. (1947). *Psychopathology and education of the brain-injured child.* New York: Grune & Stratton.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-662.

Stryker, S. (1925). Encephalitis lethargica: The behavior residuals. *Training School Bulletin, 22,* 152-157.

Szatmari, P. (1992). The epidemiology of attention-deficit hyperactivity disorders. In G. Weiss (Ed.), *Child and adolescent psychiatric clinics of North America: Attention-deficit hyperactivity disorder* (pp. 361-372). Philadelphia: Saunders.

Tannock, R., Purvis, K. L., & Schachar, R. J. (1992). Narrative abilities in children with attention deficit hyperactivity disorder and normal peers. *Journal of Abnormal Child Psychology, 21*(1), 103-117.

Teicher, M. H., Ito, Y., Glod, C. A., & Barber, N. I. (1996). Objective measurement of hyperactivity and attentional problems in ADHD. *Journal of Child and Adolescent Psychiatry, 35*(3), 334-342.

Tizard, B. E. (1968). Experimental studies of over-active imbecile children. *American Journal of Mental Deficiency, 73*(2), 548-553.

Treisman, A. (1960). Contextual cues in selective listening. *Quarterly Journal of Experimental Psychology, 12,* 242-248.

Wasserman, E., Asch, J., & Snyder, E. E. (1972). A neglected aspect of learning disabilities. *Journal of Learning Disabilities, 5*(3), 130-135.

Weinstein, C. S., & Weinstein, N. D. (1979). Noise and reading performance in an open space school. *Journal of Educational Research, 72*(4), 577-610.

Weiss, G., & Hechtman, L. T. (1993). *Hyperactive children growing up* (2^{nd} edition): *ADHD in children, adolescents, and adults.* New York: Guilford.

Whalen, C. K., & Henker, B. (1986). Cognitive behavior therapy for hyperactive children: What do we know? *Journal of Children in Contemporary Society, 19*(1-2), 123-141.

Whalen, C. K., Henker, B., Collins, D. F., Finck, D., & Domtemoto, S (1979). A social ecology of hyperactive boys: Medication effects in structured classroom environments. *Journal of Applied Behavior Analysis, 12*(1), 65-81.

Wood, D. J., & Cowan, N. (1995). The cocktail party phenomenon revisited: How frequent are attention shifts to one's name in an irrelevant auditory channel? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*(1), 255-260.

Zentall, S. S. (1975). Optimal Stimulation as theoretical basis of hyperactivity. *American Journal of Orthopsychiatry, 45*(5), 549-563.

Zentall, S. S. (1977). Environmental stimulation model. *Exceptional Children, 43*(8), 502-510.

Zentall, S. S. (1993). Research on the educational implications of attention deficit hyperactivity disorder. *Exceptional Children, 60*(2), 143-154.

Zentall, S. S., Falkenberg, S. D., & Smith, L. B. (1985). Effects of color stimulation on the copying performance of attention problem adolescents. *Journal of Adolescent Child Psychology, 13*(4), 501-511.

Zentall, S. S., & Kruczek, T. (1988). The attraction of color for active attention-problem children. *Exceptional Children, 54*(4), 357-362.

Zentall, S. S., & Shaw, J. H. (1980). Effects of classroom noise on performance and activity of 2nd grade hyperactive and control children. *Journal of Educational Psychology, 72*(6), 830-840.

Zentall, S. S., & Zentall, T. R. (1976). Activity and task performance of hyperactive children as a function of environmental stimulation. *Journal of Consulting and Clinical Psychology, 44*(5), 693-697.

Zentall, T. R., Barack, R. C., & Robin, C. (1978). Distraction as a function of within-task stimulation for hyperactive and normal children. *Journal of Learning Disabilities, 11*(9), 540-548.

Zuk, G. (1963). Over-attention to moving stimuli as a factor in the distractability of retarded and brain injured children. *Training School Bulletin, 59*(4), 150-160.

APPENDICES

Appendix A

Diagnostic Criteria for ADHD

Diagnostic Criteria for Attention-Deficit/Hyperactivity Disorder

A. Either (1) or (2):

(1) six (or) more of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

(a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities.

(b) Often has difficulty sustaining attention in tasks or play activities

(c) Often does not seem to listen when spoken to directly

(d) Often does not follow through on instructions and fails to finish school work, chore, or duties in the workplace (not due to oppositional behavior or failure to understand directions

(e) often has difficulty organizing tasks and activities

(f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)

(g) Often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)

(h) Is often easily distracted by extraneous stimuli

(i) is often forgetful in daily activities

(2) Six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity

(a) often fidgets with hands or feet or squirms in seat

(b) often leaves seat in classroom or in other situations in which remaining seated is expected

(c) often runs about or climbs excessively in situations in which it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)

(d) often has difficulty playing or engaging in leisure activities quietly

(e) is often on the go or often acts as if driven by a motor

(f) often talks excessively

Impulsivity

(g) often blurts out answers before questions have been completed

(h) often has difficulty awaiting turn

(i) often interrupts or intrudes on others (e.g., butts into conversations or games)

J. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.

K. Some impairment from the symptoms is present in two or more settings (e.g., at school [or work] and at home).

Appendix B

Initial Contact Form

INITIAL CONTACT FORM

AGE: GENDER: Female
Male

BIRTHDAY: GRADE: ETHNICITY:

Has your child ever received a formal diagnosis of ADHD? Y N
If yes, by whom?
Is your child currently on medication? Y N
If yes, what type of medication?_______________
For what is the medication prescribed?
Is your child presently receiving special education services? Y N
If yes, specify classification ________________

Appendix C

Sample Curriculum-Based Measures

Sample Curriculum Based Measures

3 + 7	4 + 9	6 + 3	7 + 5	6 + 1	4 + 1	4 + 1
2 + 5	4 + 9	7 + 1	2 + 4	3 + 4	3 + 2	4 + 5
7 + 2	6 + 4	1 + 4	4 + 6	4 + 3	4 + 9	9 + 5
4 + 3	7 + 0	5 + 2	4 + 4	5 + 2	1 + 5	4 + 9
7 + 5	5 + 3	3 + 0	6 + 1	4 + 8	4 + 0	9 + 9
4 + 1	6 + 2	1 + 3	5 + 0	4 + 3	6 + 8	6 + 7
9 + 4	8 + 0	3 + 6	3 + 2	6 + 3	1 + 7	1 + 3

5	8	8	8	8	6	6	8
x 5	x 5	x 5	x 5	x 4	x 2	x 0	x 3
0	8	4	6	5	9	1	7
x 3	x 0	x 0	x 3	x 5	x 0	x 3	x 1
9	7	3	7	7	1	1	5
x 2	x 1	x 3	x 3	x 1	x 4	x 5	x 0
5	8	8	8	8	6	6	8
x 5	x 5	x 5	x 5	x 4	x 2	x 0	x 3
0	8	4	6	5	9	1	7
x 3	x 0	x 0	x 3	x 5	x 0	x 3	x 1
2	5	6	6	6	1	4	6
x 3	x 0	x 2	x 4	x 2	x 3	x 3	x 3
5	8	8	8	8	6	6	8
x 5	x 5	x 5	x 5	x 4	x 2	x 0	x 3

Appendix D

Sample Coding Sheet with Operational Definitions of Behaviors

Sample Coding Sheet with Operational Definitions of Behaviors

Name: ______________________ Date:

Condition:

	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	Total
Off Task																					/20
Fidgeting																					/20
Vocalizing																					/20
Play w/obj.																					/20
Out of seat																					/20

Condition:

	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	Total
Off Task																					/20
Fidgeting																					/20
Vocalizing																					/20
Play w/obj.																					/20
Out of seat																					/20

Condition:

	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	Total
Off Task																					/20
Fidgeting																					/20
Vocalizing																					/20
Play w/obj.																					/20
Out of seat																					/20

Condition:

	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	15	30	45	60	Total
Off Task																					/20
Fidgeting																					/20
Vocalizing																					/20
Play w/obj.																					/20
Out of seat																					/20

Operational Definitions of Behaviors

Off Task: Any interruption of the child's attention to the mathematical task to engage in some other behavior (i.e., child breaking eye contact with the mathematical problems).

Fidgeting: Any repetitive, purposeless motion of the legs, arm, hands, buttocks, or trunk (e.g., shuffling of feet, tapping of feet, tapping a pencil, and swaying back and forth).

Vocalizing: Any vocal noise or verbalization by the child (i.e., talking, whispering, singing, humming, clicking of teeth).

Playing with objects: Touching any object in the room besides the table, chair, math problems, and pencil (i.e., touching the wall).

Out of seat behavior: Any instance in which the child's buttocks leave contact with the chair.

Appendix E

Consent Form

IRB Approval on 5/30/02

Utah State
UNIVERSITY

COMMUNITY CLINIC
Department of Psychology
Logan, Utah 84322-2810
Telephone (435) 797-3401

Date Prepared: August 19, 2002

Informed Consent

The effects of various auditory stimulation on behavior and academic performance
in children with and without ADHD

Introduction

Dr. Gretchen Gimpel, a faculty member in the Department of Psychology and Penny Sneddon, a graduate student in the Department of Psychology at Utah State University are conducting this research to investigate the effects of various auditory stimulation on the behavior and academic performance of children with and without Attention Deficit Hyperactivity Disorder (ADHD). You have been asked to take part because you are the parent of a child in first through fifth grade.

Procedures

You will be asked to complete a paper and pencil measure pertaining to your child's behavior. Following this, your child will complete several math sheets to determine your child's math achievement level. Your child will then complete four math problem sheets at his/her ability level, each five minutes in duration and completed under a different noise condition. Your child will first complete a math sheet in a No Noise condition. You child will then complete math sheets while hearing recordings of typical classroom noise, typical classroom noise with conversation in background, and typical classroom noise with background music. All testing will be videotaped and later watched by the researchers so behaviors can be coded. All testing will occur in a private room in the Department of Psychology Community Clinic or in a similar room located in the Paris Elementary School which is located in Paris, Idaho.

New Findings

You will be told of any significant new findings discovered during the course of this study via either a mailed letter or a phone call.

Risks

There are no known serious risks associated with participating in the study. You might experience some slight psychological distress completing the rating scale on your child's behavior and your child might experience some slight psychological distress completing the math skill sheets, but these risks are considered minimal. Because the math sheets will be at your child's ability level, this should decrease his/her discomfort with this task.

Benefits

Potential benefits include important implications for children and their academic success. This research could provide information that will be helpful in the design of academic interventions. The information in this study could potentially aid clinicians, parents, and teachers in their efforts to improve behavior and academic performance in children with and without ADHD.

Explanation and Offer to Answer Questions

Dr. Gretchen Gimpel, Penny Sneddon, or a student working with them, has explained this study to you and answered any questions you have at this time. If you have other questions, you may reach Dr. Gretchen Gimpel at 797-0721 or Penny Sneddon at 797-8101.

Voluntary Nature of Participation and Right to Withdraw Without Consequence

Participation in this research study is entirely voluntary. You may refuse to have your child participate or withdraw your child from the study at any time without consequence.

IRB Approval on 5/30/02

Utah State
UNIVERSITY

COMMUNITY CLINIC
Department of Psychology
Logan, Utah 84322-2810
Telephone (435) 797-3401

Date Prepared: August 19, 2002

Informed Consent

The effects of various auditory stimulation on behavior and academic performance in children with and without ADHD

Confidentiality
Information about your child will be kept confidential and will be available only to people directly involved in the project. You and your child will be assigned a code number and this number will be used when the data is stored in the computer. Public presentations on results of this study will in no way identify you or your child. The videotapes of your child will be destroyed at the end of the study. All data and videotapes will be kept in a locked file cabinet, which will be accessible only to people directly involved in the project.

IRB Approval Statement
The Institutional Review Board (IRB) for the protection of human subjects at Utah State University has reviewed and approved this research project. You may call the IRB at (435) 797-1180 with any questions regarding the approval of this project.

Copies of Consent
You have been given two copies of this Informed Consent Form. Please sign both and retain one copy for your files.

Investigator Statement
"I certify that the research study has been explained by me or my research staff, and that the individual understands the nature and purpose, the possible risks, and benefits associated with taking part in this research study. Any questions that have been raised, have been answered."

Signature of Principal Investigator and Student Investigator

Gretchen A. Gimpel, Ph.D.
Principal Investigator
(435) 797-0721

Penny L. Sneddon, B. A.
Student Investigator
(435) 797-8101

Signature of Subject

I have read and understand this consent form and I am willing to participate in this study.

Signature of parent/guardian________________________ Date______________

Child Assent
I understand my parent(s)/legal guardian is/are aware of this research study and that permission has been given for me to participate along with my parents. I understand that it is up to me to participate even if my parents say yes. If I do not want to participate I do not have to. No one will be upset if I do not want to participate or if I change my mind later and want to stop. I can ask questions I have about this study now or later. By signing below I agree to participate.

Name/Signature________________________ Date______________

Appendix F

Coach Card for CBM Math Probe

Coach Card for CBM Math Probe

The TEST ADMINISTRATOR will:

1. TELL the participant:

   "I want to see how many problems you can do in *1 (5) minutes. You will start working on the problems when I say 'START WORKING!' When you hear me say 'Stop,' you will need to immediately turn your paper over and quietly put down your pencil. At no time during the 1 (5) minutes can I talk to or help you."

1. PASS OUT a math assignment to the participant.

3. SAY "Start working!"

4. During the 1 (5) minute time period, work on independent seatwork. Do not talk to or help the participant in any way.

5. After 1 (5) minutes, SAY, "Stop, pencil down, and turn your paper over."

6. COLLECT the worksheet.

II SCORE the participant's probe, marking the number of digits correct.

II Continue to administer math probes until the instructional level is determined.

* 1 minute for probes and 5 minutes for the different noise condition testing periods.