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THEORY- AND EVIDENCE-BASED STRATEGIES FOR CHILDREN WITH ATTENTIONAL PROBLEMS

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This article reviews factors that contribute to and improve selective and sustained attention in children with attention deficit hyperactivity disorder (ADHD—the inattentive and combined subtypes). A brief review of interventions for inattention included psychostimulant medication, behavioral consequences, active-learning, practice, and cognitive behavioral (self-monitoring) techniques. Some of these traditional methods must be applied differently to children with ADHD, and some methods were found to be without empirical support. In contrast, educational interventions that involve increasing antecedent (task and setting) stimulus conditions have been demonstrated to normalize attention, and some actually improved the attentional performance of children with ADHD beyond that of their peers. © 2005 Wiley Periodicals, Inc.

Inattention is associated with significant school failure (Gathercole & Pickering, 2000) and is one of the most common childhood school problems (see Carrol, Bain, & Houghton, 1994). Inattention functions to *avoid* specific types of task or response requirements in favor of alternative environmental objects or internal thoughts. A possible explanation for this avoidance is a mismatch between task requirements and the student's learned skills or natural abilities. Skill deficits are typical of children with learning disabilities (LDs), IQ differences, sensory/motor impairments, or differences in experiential learning. Once tasks are appropriate to the skills and abilities of the child in their requirements (input, response, and cognitive processing), we can expect the child to demonstrate attention to that task. When problems remain after accommodation for these skill differences, the difficulty lies in the interaction between the requirements of the task and the attentional style of the child. These children are labeled the inattentive subtype of attention deficit hyperactivity disorder (ADHD-I) and are the focus of this article. Also included are the types of inattention associated with this disability and the social and academic outcomes, which are presented within a theoretical context with evidence-based strategies.

ADHD-I

Although the requirements for identification of the ADHD-I subtype are discussed elsewhere (Zentall, in press; Zentall & Javorsky, 1995), an initial screening for ADHD-I requires parent and/or teacher ratings on six of the following nine attention-related characteristics, as specified by the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV-TR; American Psychiatric Association, 2000).

1. is often easily distracted by extraneous stimuli
2. often fails to gives close attention to details or makes careless mistakes in schoolwork, work, or other activities
3. often does not seem to listen to what is being said to him or her
4. often has difficulty organizing tasks and activities
5. often loses things necessary for tasks or activities (e.g., school assignments, pencils, books, tools, or toys)
6. often has difficulty sustaining attention in tasks and play activities
7. often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behavior or failure to understand instructions)

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8. often avoids or strongly dislikes tasks (such as schoolwork or homework) that require mental effort
9. often forgetful in daily activities

If the child is defined with the combined subtype (ADHD-C), six symptoms of inattention are required plus an additional six items from a separate listing of hyperactivity/impulsivity (see American Psychiatric Association, 2000). When students with ADHD-I are added to children with the ADHD-C subtype, the total group represents over three quarters of the ADHD population (Wilens, Biederman, & Spencer, 2002). As well, there is evidence of overlap between these subtypes. That is, ADHD-I and ADHD-C subtypes do not differ in parent and teacher ratings of inattention when controlling for age, gender, race, and economic background (Edelbrock, Costello, & Kessler, 1984).

Academic and Social Outcomes

There are long-term academic and social outcomes for the ADHD-I and -C subtypes. For example, inattentive symptoms (but not ADHD-H symptoms) were more strongly related to academic disabilities (Willcutt & Pennington, 2000). Evidence of greater academic disability also can be found in retention figures of 72% of the ADHD-I group while only 17% of ADHD students were similarly retained in grade (Lahey, Applegate, & McBurnett, 1994); however, there is evidence challenging the notion that children with ADHD-I have greater academic underachievement (e.g., Frick et al., 1991); this evidence is related to the greater severity of symptomology required to identify children who do not have externalizing behavior (i.e., a selection bias). Yet, even when IQ was controlled, poorer math calculation performance and a greater likelihood of co-occurring LDs remained for the ADHD-I group over that observed for students with ADHD-H (Marshall, Hynd, Handwerk, & Hall, 1997).

Social unpopularity also is prevalent in children with ADHD-I, especially for elementary-aged girls, who were rejected or avoided by their peers at a rate of 62% compared to only 9% of average comparison girls (Gaub & Carlson, 1997). The unpopularity and rejection experienced by the inattentive subtype appears to be due to their greater social withdrawal and higher rates of anxiety and depression (43%), which differs from children with ADHD-H, who have lower rates of these internalizing disorders (10%) (Lahey & Carlson, 1991). Teachers and parents also perceive the ADHD-I group as better able to inhibit responses than the ADHD-H group and as exhibiting behavior that was less problematic and less likely to have a codiagnosis of conduct disorder (20 vs. 41%, respectively; Lahey & Carlson, 1991; Warner-Rogers, Taylor, Taylor, & Sandberg, 2000). Thus, there are differences between subtypes, with and without hyperactivity, primarily in internalizing versus externalizing symptoms. Because of commonalities in the underlying explanatory concepts and in their responses to intervention, this could simply indicate a difference in the expression of ADHD or in associated factors (e.g., level of anxiety).

Theoretical Basis

An optimal amount of arousal is required to maintain attentional focus and reduce response variability (Cooley & Morris, 1990). The optimal stimulation theory (OST) was first presented by Hebb (1955) and Leuba (1955) as a general explanation for the activity observed in all organisms. They provided evidence that the brain needs stimulation to maintain its functioning, and that activity was the primary means to self-regulate stimulation. Since that early conceptualization, researchers have presented evidence suggesting that individuals learn to produce stimulation through shifts in attention, thought/daydreaming, talking or changes in topics of conversation, and in seeking social/emotional stimulation and experiences (e.g., risk-taking, exciting, illegal, or aggressive behavior; Meyer & Zentall, 1995; Shaw & Brown, 1999; Streett, 1995; Zentall & Zentall, 1983).

Regardless of the way students seek additional stimulation (e.g., attention, cognition, behavior), effective performance depends on the stimulation available (a) externally from the task, setting, and time period; and (b) internally from biogenetic or "trait" differences as well as from internal "state" differences in fatigue, hormonal levels, and drugs. Trait factors are due to a range of genetic differences in need for stimulation, similar to the differences in IQ or in height. The basis of these genetic differences could be attributed to the gene DRD4, which has been found in association with novelty-seeking behavior, "a well-defined psychological trait characterized by exploratory behavior, excitability, and impulsivity" (Jensen, 2001, p. 26).

When internal and external stimulation are insufficient, individuals attempt to regulate their own effective level of stimulation by changing activities, attentional focus, or experiences. If through this behavior children are still unable to produce an optimal state of arousal, then their attention, response preparation, motor inhibition, and ability to allocate effort to a task are compromised (Banaschewski et al., 2003; Sergeant, 2000).

When the OST was first applied to students with ADHD (Zentall, 1975), they were described as needing more stimulation than their peers. Physiological researchers were the first to find underarousal in students with ADHD, but thought that these students were continually underaroused (understimulated) and overactive (Rosenthal, 1973); however, later research provided evidence to indicate that children with ADHD were physiologically underreactive only in response to some stimulus conditions (often showing smaller magnitude and delayed physiological orienting responses; see Callaway, Halliday, & Naylor, 1983; Rosenthal & Allen, 1978; Satterfield, Schell, Nicholas, Satterfield, & Freese, 1990). Recent findings have similarly concluded that students with ADHD demonstrate a suboptimal regulation of arousal (Banaschewski et al., 2003; Brandeis et al., 2002). Related evidence in support of stimulus deficiency indicated that when normal individuals were placed into sensory-deprivation environments, they performed and acted similarly to individuals with ADHD (i.e., an analogous state) (Kreppner, O'Connor, & Rutter, 2001; Zentall & Zentall, 1983). Furthermore, when sensory-deprived individuals were required to exercise, the effects of sensory deprivation were reduced (for review of classic studies, see Zentall & Zentall, 1983).

Even though all individuals need more stimulation in highly familiar settings and with repetitive or boring tasks, students with ADHD will need additional stimulation at earlier time periods. In particular, the inattentive and combined subtypes use attention to avoid boredom and get stimulation. Their greater need for stimulation alters the way they selectively attend as well as their ability to sustain attention over time.

Selective Inattention

The first four items on the DSM-IV-TR checklist (listed earlier) represent selective inattention. Almost all new, complex, or unstructured academic and social tasks have selective-attention requirements. Selective attention typically requires searching for relevant information within a complex or embedded field. "When task demands were low, ADD children outperformed their classmates in recognizing both relevant and incidental information. However, when task demands were increased, ADD children then exhibited a deficit in selective attention" (Milich & Lorch, 1994, p. 179; Tannock, Schachar, & Logan, 1993).

Age and experience are factors that can redefine the complexity of a task. As children gain experience with different types of tasks and task formatting, tasks lose their selectivity requirements (e.g., "practice effects:" Malone & Swanson, 1993; French, Zentall, & Bennett, 2003). Thus, at older age levels and with greater academic skill or practice, selectivity is less of a problem.

Across age levels, students with ADHD have an attentional bias or preference for novelty. They do not have an attentional deficit because all children attend to something; however, more than their peers, they pay attention to what is brighter, bigger, more intense, colorful, louder, or moving (Copeland & Wisniewski, 1981; Radosh & Gittelman, 1981; Zentall, 1989a). They may even become overexcited in the presence of stimulation (e.g., during group games, Berry, Shaywitz, & Shaywitz, 1985). Their attention appears to function by taking in the maximum amount of stimulation available.

For this reason, performance losses occur when nonrelevant visual stimulation is placed *into* a task. This added nonrelevant stimulation draws attention to itself and away from important detail or information. For example, shapes (e.g., a triangle) competed with conflicting words to be read (e.g., "square") to produce poorer performance selectively for this group (Leung & Connolly, 1996). As well, cartoons presented on one monitor also can interfere with math-fact performance presented on a second monitor when the child can attend to one or the other (but not both) and performance is timed. Under these conditions children with ADHD choose the more stimulating alternative (Lee & Zentall, 2002). In general, added "bells and whistles" can decrease the performance of children with ADHD more than for their peers when that stimulation is nonrelevant and is added within complex tasks or is added externally in such a way that attention cannot be shared and performance is timed (Rosenthal & Allen, 1980; Zentall, Zentall, & Barack, 1978a; Zentall, Zentall, & Booth, 1978b).

Similarly, conversations can embed thought and make learning or thinking more difficult for these children. The specific effects of sound appear to depend upon a number of factors, including task complexity and the type, intensity, and meaningfulness of that sound as well as the age, experience, and abilities of the child. That is, performance on complex, unfamiliar tasks is made worse by added conversations (Edmonds & Smith, 1985). Even small changes in conversational loudness can make a difference for young children. For example, second-grade students with ADHD (but not for their achievement-matched classmates) made more errors during high 70-dB classroom conversational noise than in low noise (64 dB) when they were working on an unfamiliar alphabet-sequencing task (Zentall & Shaw, 1980). Similarly, within listening tasks, (a) added detail and description can reduce comprehension for students with ADHD relative to comparison children (e.g., Shroyer & Zentall, 1986), and (b) highly interesting cartoons and toys can decrease the recall of causal connections, even though students with ADHD recalled as many facts (for a review of research by Lorch and colleagues, see Zentall, Cassady, & Javorsky, 2001).

In contrast to the previous findings, there rarely is a loss of performance from distal stimulation, even when cartoons or gadgets were used (during complex, easy, or boring tasks: Lawrence et al., 2002; Milich & Lorch, 1994; Steinkamp, 1980). As well, cross-modal stimulation (added noise during visual tasks) apparently had no detrimental effects (e.g., Carrol et al., 1994). Finally, there was no loss in reading performance even when elementary-level students with ADD were observably "distracted" (i.e., looked more than their peers) in the presence of combinations of telephones ringing, calculator noises, lights, and oscilloscope patterns than during nonstimulating conditions (Bremer & Stern, 1976).

Although most types of performance are not disrupted by external stimulation (e.g., gadgets, lights, noises), preferences for what is bright, loud, or intense can replace attention to subtle information in the external social environment. For example, less attention will be directed to small, detailed, or nonaggressive cues and nonemotional feedback from peers (Cunningham, Siegel, & Offord, 1985; Meyer & Zentall, 1995; Tant & Douglas, 1982; Zentall & Gohs, 1984). As well, children with ADHD attend to the stimulation in their physical and social environments more than to transitory internal thoughts and feelings. That is, the biasing of attention to external novelty can reduce the amount of attention directed to internal stimuli from the self (e.g., thoughts, plans, strategies, values, subtle feelings). This can be a problem because self-monitoring of behavior, standards, values, and other internal states is critical for appropriate social behavior. Insufficient attention directed internally to (a) current internal states, (b) experiential histories, or (c) intentions and future expectations could explain the evidence that students with ADHD are more likely to place responsibility outside themselves (Mrug, Hoza, & Gerdes, 2001). This tendency could explain their proclivities toward blaming others, using excuses, or feeling disconnected from the outcomes of their behavior.

In summary, selective attention to novelty (attentional bias) can lead to difficulty dedicating attention to relevant information within the self and to informational and subtle cues available in social and task contexts. Impairments can be recognized as reliance on external cues and feedback from the immediate environment. Students also can have difficulty locating what is important in their tasks, especially when relevant information is subtle or ambiguous and when the task field is complex or has other irrelevant, but attractive, actions or features. Impairments here can be recognized as errors early in performance or a disorganized approach to new or complex tasks, contexts, or social requirements.

In contrast, most types of novelty (e.g., gadgets, noise, lights, color, shapes) placed in the distal environment (extra-task) will not disrupt performance. That is, children with ADHD can choose to look at visual novelty in the environment and then look back to their tasks without a loss in performance and perhaps with an increased ability to attend. Only appealing cartoons will disrupt timed or rote performance, but will not disrupt performance of an engaging task or activity. On these *rare* occasions when distractors do have negative effects, "the present study suggests that their influence fades away rapidly with repeated trials" of a task (Schweitzer & Sulzer-Azaroff, 1995, p. 683). Thus, additional task exposure will help children with ADHD-I learn to identify and respond to relevant elements.

The major implications for instruction can be derived from an understanding that any strong stimulus has the capacity to captivate and reinforce the attention of children with ADHD. From these general principles and evidence, Table 1 presents specific evidence-based practices that can be used to direct the attention of students with ADHD.

Sustained Inattention

Problems of sustained attention are the second five items in the regrouped DSM-IV-TR checklist (listed earlier). Sustained inattention is documented by errors that are typically made at the end of task performance. All children with mild disabilities will have difficulty maintaining attention to tasks that have been difficult for them. Their greater initial effort leaves them less able to sustain effort, particularly in the area(s) of their specific LDs. Young children and children with ADHD and co-occurring LD, in particular, will have greater difficulty sustaining attention.

Children with ADHD, without additional LDs, have specific difficulties sustaining attention to long, rote/repetitive, or non-active tasks. Thus, their sustained attentional "deficit" is related to the length, familiarity, or repetitiveness of the task. While performing these tasks, students with ADHD look around or change their attentional focus more often than their peers, especially during later performance (e.g., Zentall, 1985, 1986; Zentall & Zentall, 1976; Zentall, Falkenberg, & Smith, 1985).

The most effective intervention for sustained attention is psychostimulant medication (e.g., Hoagwood, Kelleher, Feil, & Comer, 2000), which is effective in improving speed and reducing errors on memory and sustained attention types of tasks (Miranda, Presentacion, & Soriano, 2002). In the classroom, performance improvements are seen in a decrease of careless errors and an increase in work completed (academic productivity)—with about half the children showing improved work quality (accuracy) and the remainder with no gains or a decline in performance (see Abikoff

Table 1
Evidence-Based Practices for Guiding Selective Attention

Change the Task

1. *Eliminate irrelevant cues*, such as:
   a. non-relevant visual novelty that *overlaps* visual information,
   b. engaging visual stimuli (toys, cartoons) that compete with practice or listening tasks,
   c. verbal detail *within* listening tasks, and
   d. conversations during complex thinking tasks (see text for references).
   Allow *all* children in the classroom the option of working in areas away from conversations during new or complex tasks, as long as this placement is temporary, self-selected, and provides access to visual stimulation, peers, resources, and opportunities for movement.
2. *Highlight relevant information* (global structure and relevant detail):
   a. *use global cues or models* to focus attention onto 'the big picture,' early in performance, during social tasks, or when giving directions. *Observational* learning can be enhanced with child-models, who are active or talkative (Copeland & Weisbrod, 1980; Goodwin & Mahoney, 1975; for review see Meharg & Woltersdorf, 1990). Students with ADHD prefer *global* cues ("it looks like") in problem solving tasks over additional detail ("it has the following parts") (Zentall & Gohs, 1984), possibly because they spend less time examining a visual task or social scenario (e.g., Milch-Reich, Campbell, Pelham, Connelly, & Geva, 1999; Vargas, Zentall, & Wilbur, 2002).
   b. focus attention to the *essential elements*, which will help with rapid analysis of complex material. To this purposes, students with ADHD were presented with colored slides of paintings, each with a slide next to it of (a) essential black/white elements of the composition or (b) a black and white version of each painting (Vargas et al., 2002). Students made the greatest gains from the essential elements condition. The implication for practice derived from this study and related work was that reducing the initial complexity of visual tasks can help students with ADHD, especially when they are young, learning disabled, or from a second language culture.
   c. use verbal highlighting with vocal alterations in tone, speed, and use of pauses in listening tasks. "Children's attention is increased by . . . children's voices, peculiar voices. . ." (Milich & Lorch, 1994, p. 181).
   d. use verbal questions to direct attention to preceding events in social experiences. For example, asking children to recount the events in a preceding social situation improved their identification of solutions to social problems to a level equivalent to their peers (Zentall, Cassady, & Javorsky, 2001).
   e. *use* color, bold emphasis, animation, or verbal cues to guide the attention of students with ADHD-I to important details early during the performance of academic and social tasks. For example when color was added to letters that were difficult to remember (i.e., irregular non-phonetic letters) in 6-choice spelling recognition task, students with ADHD actually outperformed students matched in spelling performance without ADHD (Zentall, 1989a). Similarly attention can be focused by coloring the tops of letters (e.g., top of the letter 'o') to improve handwriting performance of elementary children with ADHD, who typically fail to close up their letters, making their handwriting illegible (Zentall & Kruczek, 1988).
   f. *add non-relevant color or other change, such as animation, later after* the student has had initial practice. Nonspecific color that is added early only to increase the attractiveness of a task, is likely to disrupt new or complex task performance, especially for young students with ADHD more than for their peers (Zentall, 1989a; Zentall, Zentall, & Booth, 1978; Zentall & Kruczek, 1988; Zentall, Grskovic, Javorsky, & Hall, 2000).

Change Task Instructions or Task Sequencing

1. *Begin with simple formatting and easier tasks* that get more difficult and more complex after a period of practice. Children with and without ADHD read more words correctly and with a higher accuracy percentage when easy words were presented first (Zentall & Meyer, 1987). Flood and Wilder (2002) "indicated that the highest rates of off-task behavior occurred when the child was presented with difficult academic tasks." However, they also found that very easy tasks resulted in boredom and also led to undesirable behavior for students with ADHD.
2. Encourage all students to set their own goals and to evaluate their own performance in relation to samples of their own work—not in comparison to others (e.g., Jagacinski & Nicholls, 1987; Zimmerman, 2001).
3. Teach students to use self-instructional strategies prior to beginning tasks. Teachers were given 12 hours of education in ADHD characteristics, educational accommodations, behavior modification, and an additional 6 hours in how to teach children self-instructional questioning strategies: "what is my problem," "what is my plan," "am I following my plan," and "how did I do" (Miranda, Presentacion, & Soriano, 2002). This intensive multicomponent teacher education program improved measures of children's selective attention, sustained attention, and language, and reduced impulsivity relative to a non-treatment/non-attention control group. Overall, specific statements should be taught to younger students (e.g., "I need to start at the top") and general strategies (e.g., "I should plan out exactly what I need to do") taught to older children (for review see Zentall, 1989b).

(continued)

Table 1 Continued

Provide Practice

1. *Provide additional practice* to reduce task selectivity requirements, because there is a positive relationship between length of time examining a visual stimulus and subsequent understanding of that stimulus (Gardner, 1990). Repeated exposure can be useful, as long as practice sessions are short for students with ADHD.
   a. use practice sessions of finding objects or listening for sounds/words. For example, children were identified by teachers for their failure to complete assignments and pay attention in class (Semrud-Clikeman et al., 1999). Repetitive 60-min selective attention practice-sessions were conducted after school in small groups that met twice a week for 18 weeks. The sessions required children to find visual or auditory cues within visual or auditory contexts of similar and overlapping stimuli. Children also reviewed their scores from prior sessions, discussed strategies, and set daily goals (self-evaluation and goal-setting). Assessments indicated that the ADHD group who received attention-training scored as well as their non-ADHD classmates and significantly better than the children in the ADHD group who did not receive intervention (Semrud-Clikeman, 1999).
   b. use practice sessions of motor movements signaled by auditory or visual cues. Boys with ADHD were randomly assigned to one of three conditions—a control or two practice conditions of 15 1-hour practice sessions: (i) timing hand and foot motor movements to an auditory signal (a metronome) and (ii) timing hand movements to a visual input (a nonviolent videogame condition). Shaffer et al. (2001) reported that the two practice groups improved on 40–53 of the 58 measures of attention, motor control, parent rated aggression, and reading more than the control group, whose gains were at chance level. The metronome timing condition produced greater gains than the video game condition.

Change the Setting

1. Provide setting cues for students to self-monitor their own immediate behavior *and internal* standards. Self-monitoring procedures (with taped signals) can direct attention back to the self and to self-controlling strategies—helping children control responses they can already make (e.g., to go slower, to review responses, for review see Zentall, 1989b).
   a. use a mechanical device to signal a child to self-attend to behavior or to internal emotional reactions, such as anger or anxiety, and then to record the presence or absence of a behavior in response to those internal states. The effectiveness of self-monitoring behavior for children with ADHD has been demonstrated using current-day mechanical devices, such as electronic diaries, PDAs, or hand-held computers (Reid, Trout, & Schartz, in press). Only adult presence may be necessary for children to comply with self-monitoring procedures (Cameron & Robinson, 1980; Varni & Henker, 1979).
   b. add reinforcement that the child self-administers (e.g., stars, stamps) or self-charting or self-evaluation. These procedures have been demonstrated to increase the number of academic problems attempted, number correct, task-persistence, and on-task attention (De Haas & Warner, 1991; Harris, Graham, Reid, McElroy, & Hamby, 1994; Prater, Hogan & Miller, 1992; Maag, Reid & DiGangi, 1993; Levendoski & Cartledge, 2000).
   c. add mirrors to increase task persistence, productivity, and accuracy. Mirrors can be placed such that the child can view him/herself while performing a task. For students with ADHD, mirrors improved their homework production and accuracy three fold and increased their word search accuracy to levels equivalent to their peers (Hall & Zentall, 2000; Zentall, Hall, & Lee, 1998). The effects of the mirror were especially beneficial for those children with ADHD who looked at the mirror (i.e., were 'distracted'), relative to comparison children and to children with ADHD who looked at the mirror less.
   d. use fantasy- or journal-writing, an observer or camera to increase self-monitoring of their own behavior, internal strategies or standards (Carver, 1979; Carver & Scheier, 1981; Meichenbaum, 1979).

Change the Consequences or Feedback for Task Performance

1. *Use cross-modal response options*. Visual feedback (right/wrong) in close proximity to computer-presented visual task stimuli resulted in more errors and more 'undesirable behaviors' for students with ADHD than non-feedback conditions (Burt & Ryan, 1997). Feedback may have overlapped or embedded relevant task stimuli. Students with ADHD also performed less accurately on a task than their peers only when the math problems were visual with visual response options (answers). However, they performed as well as their peers when the problems were spoken by the computer with possible answers presented visually (Bennett, Zentall, Giorgetti-Borucki, & French, 2005). In other words, provide auditory feedback for a visual task and visual feedback for an auditory task.

& Hechtman, 1996; Rapport, Denney, DuPaul, & Gardner, 1994); however, long-term outcomes in vocation or academic achievement have been disappointing, including no gains in higher level skills such as reading comprehension, math-problems solving, or creative expression (American Academy of Pediatrics, 2001; Hinshaw, 1994; Mrug et al., 2001; Richters et al., 1995; Runnheim, Frankenberger, & Hazelkorn, 1996; Swanson, McBurnett, Christian, & Wigal, 1995; The MTA Cooperative Group, 1999). A lack of achievement gains might be expected given that medication cannot selectively guide attention nor promote cognitive reorganization (Miranda et al., 2002). That is, psychostimulants *cannot* teach children to look at certain parts of the curriculum.

Significant side effects also can be demonstrated (motor repetitive actions, reduced responsivity, and overfocusing of attention: Tannock et al., 1993). Compliance with treatment also can be low. Wolraich et al. (1990) reported that 88% of children with ADHD had received methylphenidate at some time; however, at any one point in time, only about 6% of these children may be receiving medication, and about a quarter of medication dosages were missed in a 3-month period of time. Furthermore, 20% of children had discontinued treatment by the 4th month, 44% by the 10th month, and only 22% survived a 2-year follow-up (for review, see Whalen & Henker, 1991).

The second most frequently used strategies include behavior modification and cognitive behavioral strategies. When applying these strategies, it is important to remember that students with ADHD respond differently from other children to consequences. These differences are due to the fact that consequences can provide three positive effects: (a) feedback about correct/incorrect, (b) positive/negative social effects, and (c) stimulation effects. For children with ADHD, stimulation alone, especially intense stimulation, can act as a reinforcer (Brand & van der Vlugt, 1989; Lee & Zentall, 2002). In other words, the positive and negative effects may be less important to these children than the intensity of that social stimulation. For example, responding loudly and emotionally to children with ADHD when they behave inappropriate may stop them initially, but it can actually increase subsequent inappropriate behavior (Meyer & Zentall, 1995). For students with ADHD, the most effective cognitive behavioral strategies involve self-monitoring, self-reinforcement, and self-evaluation (Reid et al., in press; Zentall, 1989b).

Finally, the third set of strategies to improve sustained attention involves changes in the task and the environment (antecedents). These techniques are typically used by general and special educators, who provide direct services to children with ADHD-I and -C. For improvements in sustained attention (i.e., after the child has mastered the selective-attention requirements of the task), added novelty (relevant or nonrelevant) has been documented to improve the sustained attention of students with ADHD more than for matched comparisons when it is placed (a) prior to a visual creativity task (i.e., an exciting car-chase video: Shaw & Brown, 1999) and (b) within a task (color added to search, sustained attention, handwriting, copying, or matching-figures tasks: Imhof, 2004; Lee & Asplen, in press; Zentall, 1985, 1986; Zentall & Dwyer, 1988; Zentall et al., 1985). That is, even nonrelevant color can produce normalized performance for students with ADHD during sustained-attention tasks, which is similar to the effects obtained by psychostimulant medication (i.e., improved behavior, attention, and productivity and reduced careless errors).

These findings stand apart from assumptions that many professionals make about students with ADHD-I. Most adults assume that (a) the environment, rather than the task, is responsible for the child's off-task behavior; and (b) looking away from a task will necessarily result in reduced performance. Neither of these assumptions has been empirically supported, even by the research of Cruickshank and colleagues, who were the first educators to advocate the use of cubicles for students with ADHD (Cruickshank, Bentzen, Ratzeburg, & Tannhauser, 1961). Related past research also has failed to support stimulus reduction (e.g., see Zentall, 1993, 1995), and current research no longer assesses cubicles, even though many current sources still recommend their use (e.g., Paul & Epanchin, 1991; Reid, 1999, p. 3). Educators do see that when the child is placed in a cubicle, there is nowhere else to look except at the task; however, as previously reviewed, performance will be disrupted more than that of comparisons only when (a) novel colors, movements, or shapes *overlap* with the visual information within the task, (b) conversations overlap with the thinking required for processing task information, or (c) cartoons are adjacent to a repetitive practice task, but not when the child is performing an interesting task. Performance is not differentially disrupted by classroom visual or noise stimulation in the distal environment. Children can choose to look at the environment and then look back at their tasks without a loss in performance. Perhaps educators continue to recommend cubicles because they observe decreased off-task attention without assessing or making a distinction between attention and performance.

In summary, there is less novelty over time in familiar environments and after repeated exposure to practice tasks (e.g., math facts, handwriting, routines). Because it is more difficult for students with ADHD to remain alert under conditions of decreasing novelty, they rush through assignments and make more careless errors than their classmates. As well, when tasks are overly familiar, long, repetitive, or nonmeaningful, students with ADHD-I refocus their attention away from the task and towards what is novel or intense in their internal or external environments. Changing the focus of visual attention, topic of conversation, or behavioral activity typically occurs earlier for students with ADHD-I and ADHD-C than for their classmates. More disruptively, students with ADHD-C may attempt to self-generate stimulation through inappropriate activity, talking, or even aggression.

Methods to improve sustained attention include the use of medication, behavioral consequences, and altering antecedent task and environmental conditions (see Table 2). These are derived from theory, with confirmatory evidence indicating that any strong stimulus has the capacity to maintain the attention of students with ADHD.

General Summary

Few individuals can attend to tasks that are too difficult or too simple. Tasks are often too difficult for children with cognitive and LDs, who demonstrate fatigue earlier from the amount of effort required to perform complex tasks. When the appropriate task level, input modality, and response requirements for that child have been identified and accommodations have been provided for these differences, adapting instruction for children with ADHD-I would be the *next* step.

For all children, there is a functional or purposeful relationship between what they attend to and what they avoid. Children have different needs for change or novelty, due to biogenetic, over- or undersensitivity to the stimulation available from their tasks and environments. For example, the selective attention of children with autism is directed to objects of low stimulus intensity (e.g., "sameness," detailed, familiar stimuli) (for review, see Zentall & Zentall, 1983). In contrast, students with ADHD have attentional problems that are related to the highly reinforcing nature of stimulation (change or novelty). There is a greater pull from added stimulation within tasks or environments because this stimulation allows them to achieve a more optimal level of internal arousal that is necessary for attention and performance. They do not have an attentional deficit, per se; they have an attentional bias or preference for novelty (i.e., to pay attention to what is bigger, more intense, colorful, or moving).

Although there are some gains from the attentional selectivity of students with ADHD (e.g., unique and intense interests, originality, creativity, spontaneity, and often humorous topics of conversation or perspectives: Shaw & Brown, 1999; Zentall, 1988, in press), selective attention to intense stimulation can be at a cost. Educators observe that students with the inattentive and combined subtypes have greater difficulty getting "on track." For example, homework is a major problem for these students, with selective inattention contributing to specific difficulties in getting the assignments, understanding the directions, and organizing an approach (Zentall & Goldstein, 1999).

Table 2
Evidence-Based Practices for Maintaining Attention

Change the Task

1. *Reduce the quantity of material or the time* dedicated to practicing or redoing a task in any one sitting (e.g., break one task into smaller parts to be completed at different times—three short reports instead of one long one, use multiple breaks, distributed practice rather than massed practice). This can also be accomplished by increasing the pace of responding (van der Meere, Shalev, Borger, & Gross-Tsur, 1995). Under fast-paced responding to rote tasks, especially with an adult present, differences in attention between students with ADHD and their peers disappeared (Leung, Leung, & Tang, 2000) or were reduced (van der Meere et al., 1995). (Fast pacing does not improve creativity, planning, or complex task performance such as would be required for reading comprehension. Students may need to regulate their own instructional pace during these selective attention task conditions.)
2. *Shorten task instructions* by using use fewer words in explaining tasks (concise and global verbal directions, Zentall & Gohs, 1984).
3. *Increase novelty at various intervals*—before, during, and especially toward the end of repetitive or rote tasks (see references in the text).
4. *Decease the repetitiveness* of tasks. Children with ADHD are more likely to demonstrate off-task and behavioral problems when given repetitive information (Shroyer & Zentall, 1986).
5. *Increase the quality of instruction*. Students can sustain attention for relatively long periods of time when the task is engaging (e.g., television, Milich & Lorch, 1994). Identify areas where there is already persistence of attention (e.g., with computers) and use these interests to reinforce persistence in other content areas.

Change Task Instructions or Between-Task Events

1. *Increase opportunities for child-initiated movements* during the task, especially towards the end (e.g., active games or drills, calculators, organizing or filing materials, cleaning the chalk board, choices). For example, when children with ADHD could push a button to see nature slides during the performance of a listening attention task, their performance was equivalent to the performance of their peers (Zentall & Meyer, 1987; Leung et al., 2000).
2. *Increasing opportunities for movement between tasks* to decrease absences, out-of-seat behavior, talking out, and teacher ratings of hyperactivity and aggression (e.g., Bass, 1985; Berger, 1981; Evans, Evans, Schmid, & Pennypacker, 1985; Elsom, 1980; McGimsey & Favell, 1988; Walker, 1980).

Change the Setting

1. *Add music or accompanying sound*. Elementary students with ADHD, but not their peers, performed more math problems and were more accurate in the presence of music than in the presence of silence or with speech in the background (Abikoff, Courtney, Szeibel, & Koplewicz, 1996; Scott, 1970). By junior high, even typical students were reported to be more likely to do homework when there was music than when it was quiet at home (Bryan & Nelson, 1994). However, because students with ADHD have poorer visual-motor performance, they can make more errors under fast music conditions when asked to perform a precision motor task or a free drawing task (Klein, 1982). Even non-conversational sounds can have beneficial effects during the performance of familiar tasks. For example, fewer reading omission errors were observed for students with ADD than for their reading-matched peers during high classroom noise than low noise conditions (i.e., not conversations, Zentall & Shaw, 1980).
2. Enrich the environment with novelty (visual and auditory). Settings that improve attention and reduce the talkativeness of students with ADHD are novel activities (tests, films, and free time) more than routine lecture and seatwork activity-settings (Zentall, 1980). Similar attention gains have been reported by parents who rated 85% of after-school or weekend outdoor 'green' activities (e.g., playing in the woods) as better than indoor nongreen activities (e.g., shopping, watching TV) for students with ADHD (Taylor, Kuo, & Sullivan, 2001).
3. Change the position of the child in the classroom. Although teacher presence does not eliminate performance errors, it can improve sustained attention (van der Meere et al., 1995) and decrease time off-task (Steinkamp, 1980), perhaps because the teacher is the strongest source of social stimulation. However, teacher presence alone is insufficient to improve performance without a change of instruction.

Change the Consequences of Task Performance

1. *Increase the intensity of positive feedback*. Reduced negative behavior has been observed in students with ADHD and greater use of 'friendly' toys when prosocial behavior was responded to with loud and emotional social reactions (Meyer & Zentall, 1995). Similarly, verbal praise alone did not appear to produce improvements at least for on-task behavior (Abramowitz & O'Leary, 1991). However, children with hyperactivity outperformed their classmates on an attentional coding task when a primary reinforcer (candy) was used in the presence of distractions (colorful pictures, paper streamers, toys, comic books, balls, a mirror, a Bobo clown, a punching bag, audio recording of participants playing) (Worland, North-Jones & Stern, 1973). To sustain attention on this simple boring task, the children appeared to need a 'high dose' of concurrent antecedent stimulation as well as an anticipated candy consequence.
2. *Increase the frequency of* reinforcement to encourage sufficient practice (e.g., Hallahan, Tarver, Kauffman, & Graybeal, 1978) and to help students with ADHD behave more like their classmates (Sagvolden, Metzger, Sagvolden, 1993).
3. *Increase the immediacy of feedback*. Immediate feedback can provide increased stimulation to help students with ADHD sustain attention. In fact children with ADHD are more influenced by current rewards than they are by their past experiences with reward (Tripp & Alsop, 1999).
4. *Decrease* the frequency and intensity of negative consequences. It is important to use soft, private, firm, non-emotional reprimands, delivered with eye contact and within one meter (but not as far away as 3 meters) to quiet behavior and the reduce disruptiveness of these students (e.g., Abramowitz & O'Leary, 1991).

Selective attention problems also are identified for these students when listening to instructions or locating important information, especially when that information is subtle or the context has confusing elements or descriptions. As well, conversations in the environment can overlap with the thinking and listening processes required for learning new or complex tasks. The disruptive effects of conversation are most evident for young children and children with verbal LDs. In general, added detail or information that overlaps (shares the same space, sensory features, or content) with features of the relevant task can interfere with performance for children with ADHD more than for their peers; however, visual environmental stimulation that is distal from a task typically will not interfere, and methods such as cubicles have consistently not been supported by research. Cubicles isolate children socially and educationally and produce no academic gains.

There are a number of evidence-based educational practices to improve the selective attention of students with ADHD-I and ADHD-C subtypes (see Table 1). In general, these involve: (a) highlighting a task's global structure, essential elements, or relevant task details (e.g., parts of problems, words, sentences, or instructions); (b) focusing attention internally to less visible information (one's own behavior, strategies, intentions, or feelings) through the use of questioning, self-monitoring, or mirrors; and (c) providing additional task practice. For example, when relevant detail is highlighted, students with ADHD can actually perform significantly better than their matched peers. An alternative to placing emphasis on relevant detail is to highlight the overall structure of a task or situation using global points, diagrams, maps, or analogies. As well, educational methods such as self-monitoring can increase self-focused attention and thereby improve performance for students with ADHD. Because task errors in selective attention occur early in performance, repeated practice in small doses or additional experience with a task ("practice effects") also can improve selective-attention performance.

Second, students with ADHD have greater difficulty staying on track. Because of decreased arousal, they satiate faster (habituate) or get bored more readily than their peers (i.e., rapid physiological adaptation: Allen, 1986). This problem becomes magnified in a homework setting due to the repetitive nature of homework assignments (i.e., over a half of homework is unfinished class work, and another quarter is practice material: Zentall & Goldstein, 1999). To help these students maintain attention during the performance of tasks that require practice or a narrow focus (e.g., memory or rote tasks), the most common educational accommodations involve decreasing time and increasing change or novelty (see Table 2).

Most empirical work has demonstrated that students with ADHD respond differently from their classmates to novelty (e.g., color, music, active responding) in the environment. For example, their performance can be improved to the same level as their peers when novelty is added. A few novelty interventions have actually produced improved sustained-attention performance for students with ADHD that was better than the performance of matched typical children. Unfortunately, students with ADHD also will adapt or get bored with this novelty more rapidly than their peers. To stay ahead, educators and their consultants will need to make periodic changes in the settings, tasks, and rewards used or allow these children to chose their content interests or direct their own pacing, order, and length of tasks.

In conclusion, there are many strategies that educators have at their disposal for setting the occasion for optimal responses from children with attentional problems. These strategies are grounded in theory with over 30 years of research on students with ADHD and their responses to stimulation. Although the attention of students with ADHD (the inattentive and combined subtypes) functions primarily to avoid boredom and get stimulation, the preferred type(s) of stimulation (sensory, cognitive, positive or negative emotional, social) appears to depend on individual factors that can be assessed in a functional analysis of individual children with ADHD (e.g., see DuPaul & Ervin, 1996; Zentall, in press; Zentall & Javorsky, 1995).

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, 238–246.

Abikoff, H.B., & Hechtman, L. (1996). Multimodal therapy and stimulants in the treatment of children with attention deficit disorder. In E.D. Hibbs & P. Jensen (Eds.), Psychosocial treatment for child and adolescent disorders: Empirically based strategies for clinical practice (pp. 668–696). Washington, DC: American Psychological Association.

Abramowitz, A.J., & O'Leary, S.G. (1991). Behavioral interventions for the classroom: Implications for students with ADHD. School Psychology Review, 20, 220–234.

Allen, T.W. (1986). Styles of exploration in control, attention deficit disorder with hyperactive and learning disabled children. Journal of Learning Disabilities, 19, 351–353.

American Academy of Pediatrics. (2001). Clinical practice guideline: Diagnosis and evaluation of the child with attention-deficit/hyperactivity disorder. Pediatrics, 105, 1158–1170.

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders (4th ed., revised). Washington, DC: Author.

Banaschewski, T., Brandeis, D., Heinrich, H., Albrecht, B., Brunner, E., & Rothenberger, A. (2003). Association of ADHD and conduct disorder—Brain electrical evidence for the existence of a distinct subtype. Journal of Child Psychology and Psychiatry, 44, 356–376.

Bass, C.K. (1985). Running can modify classroom-behavior. Journal of Learning Disabilities, 18, 160–161.

Bennett, D.E., Zentall, S.S., Giorgetti-Borucki, K., & French, B.F. (2005). Computer-administered choice and modality of math instruction for students with and without symptoms of attention deficit hyperactivity disorder. Manuscript submitted for publication.

Berger, M. (1981). Remediating hyperkinetic behavior with impulse control procedures. School Psychology Review, 10, 405–407.

Berry, C.A., Shaywitz, S.E., & Shaywitz, B.A. (1985). Girls with attention deficit disorder: A silent minority? A report on behavioral and cognitive characteristics. Pediatrics, 76, 801–809.

Brand, E., & van der Vlugt, H. (1989). Activation: Base-level and responsivity A search for subtypes of ADDH children by means of electrocardiac, dermal and respiratory measures. In T. Sagvolden & T. Archer (Eds.), Attention deficit disorder: Clinical and basic research (pp. 137–150). Hillsdale, NJ: Erlbaum.

Brandeis, D., Banaschewski, T., Baving, L., Georgiewa, P., Blanz, B., Schmidt, M.H., et al. (2002). Multicenter P300 brain mapping of impaired attention to cues in hyperkinetic children. Journal of the American Academy of Child and Adolescent Psychiatry, 41, 990–998.

Bremer, D.A., & Stern, J.A. (1976). Attention and distractibility during reading in hyperactive boys. Journal of Abnormal Child Psychology, 4, 381–387.

Bryan, T., & Nelson, C. (1994). Doing homework: Perspectives of elementary and junior high school students. Journal of Learning Disabilities, 27, 488–499.

Burt, K.L., & Ryan, C.L. (1997). An investigation of the effects of medication and the use of computerized feedback in task performance of AD/HD children. Issues in Special Education and Rehabilitation, 12, 56–70.

Callaway, E., Halliday, R., & Naylor, H. (1983). Hyperactive children's event-related potentials fail to support underarousal and maturational-lag theories. Archives of General Psychiatry, 40, 1243–1248.

Cameron, M.I., & Robinson, V.M.J. (1980). Effects of cognitive training on academic and on-task behavior of hyperactive children. Journal of Abnormal Child Psychology, 8, 405–420.

Carrol, A., Bain, A., & Houghton, S. (1994). The effects of interactive versus linear video on the levels of attention and comprehension of social behavior by children with attention disorders. School Psychology Review, 23, 29–43.

Carver, C.S. (1979). A cybernetic model of self-attention processes. Journal of Personality and Social Psychology, 37, 1251–1281.

Carver, C.S., & Scheier, M.F. (1981). Attention and self-regulation: A control therapy approach to human behavior. New York: Springer.

Cooley, E.L., & Morris, R.D. (1990). Attention in children: A neuropsychologically based model of assessment. Developmental Neuropsychology, 6, 239–274.

Copeland, A.P., & Weissbrod, C.S. (1980). Effects of modeling on behavior related to hyperactivity. Journal of Educational Psychology, 72, 875–883.

Copeland, A.P., & Wisniewski, N.M. (1981). Learning disability and hyperactivity: Deficits in selective attention. Journal of Experimental Child Psychology, 32, 88–101.

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

Cunningham, C.E., Siegel, L.S., & Offord, D.R. (1985). A developmental dose–response analysis of the effects of methylphenidate on the peer interactions of attention deficit disordered boys. Journal of Child Psychology and Psychiatry, 26, 955–971.

De Haas-Warner, S.J. (1991. Effect of self-monitoring on pre-schoolers' on task behavior: A pilot study. Early Childhood Special Education, 11, 59–73.

DuPaul, G.J., & Ervin, R.A. (1996). Functional assessment of behavior related to attention-deficit/hyperactivity disorder: Linking assessment to intervention design. Behavior Therapy, 27, 601–622.

Edelbrock, C., Costello, A.J., & Kessler, M.D. (1984). Empirical corroboration of Attention Deficit Disorder. Journal of the American Academy of Child Psychiatry, 23, 285–290.

Edmonds, E.M., & Smith, L.R. (1985). Students' performance as a function of sex, noise, and intelligence. Psychological Reports, 56, 727–730.

Elsom, S. (1980). Self-management of hyperactivity: Children's use of jogging. Dissertation Abstracts International, 40(08), 3176B(UMI), No. 8104639.

Evans, W.H., Evans, S.S., Schmid, R.E., & Pennypacker, H.S. (1985). The effects of exercise on selected classroom behaviors of behaviorally disordered adolescents. Behavior Disorders, 1, 42–51.

Flood, W.A., & Wilder, D.A. (2002). Antecedent assessment and assessment-based treatment of off-task behavior in a child diagnosed with attention deficit-hyperactivity disorder (ADHD). Education and Treatment of Children, 25, 331–338.

French, B.F., Zentall, S.S., & Bennett, D. (2003). Short-term memory of children with and without characteristics of attention deficit hyperactivity disorder. Learning and Individual Differences, 13, 205–225.

Frick, P.J., Kamphaus, R.W., Lahey, B.B., Loeber, R., Christ, M.G., & Hart, E.L. (1991). Academic underachievement and the disruptive behavior disorders. Journal of Consulting and Clinical Psychology, 59, 289–294.

Gardner, H. (1990). Art education and human development. Los Angeles: Getty Center for Education in the Arts.

Gathercole, S.E., & Pickering, S.J. (2000). Working memory deficits in children with low achievements in the national curriculum at 7 years of age. British Journal of Educational Psychology, 70, 177–194.

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

Goodwin, S.E., & Mahoney, M.J. (1975). Modification of aggression through modeling: An experimental probe. Journal of Behavior Therapy and Experimental Psychiatry, 6, 200–202.

Hall, A.M., & Zentall, S.S. (2000). The effects of learning station on the completion and accuracy of math homework for middle school students. Journal of Behavioral Education, 10, 123–137.

Hallahan, D.P., Tarver, S.G., Kauffman, J.M., & Graybeal, N.L. (1978). A comparison of the effects of reinforcement and response cost on the selective attention of learning disabled children. Journal of Learning Disabilities, 11, 430–438.

Harris, K.R., Graham, S., Reid, R., McElroy, K., & Hamby, R.S. (1994). Self-monitoring of attention versus self-monitoring of performance: Replication and cross-task comparison studies. Learning Disability Quarterly, 17, 121–139.

Hebb, D.O. (1955). Drives and the CNS (conceptual nervous system). Psychological Review, 62, 234–254.

Hinshaw, S.P. (1994). Attention deficits and hyperactivity in children (Vol. 29). Thousand Oaks, CA: Sage.

Hoagwood, K., Kelleher, K.J., Feil, M., & Comer, D.M. (2000). Treatment services for children with ADHD: A national perspective. Journal of the American Academy of Child and Adolescent Psychiatry, 39, 198–206.

Imhof, M. (2004). Effects of color stimulation on handwriting performance of children with ADHD without and with learning disabilities. European Child and Adolescent Psychiatry, 13, 191–198.

Jagacinski, C.M., & Nicholls, J.G. (1987). Competence and affect in task involvement and ego involvement: The impact of social comparison information. Journal of Educational Psychology, 79, 107–114.

Jensen, P.S. (2001). AD/HD What's up, what's next? Attention!, 7, 24–27.

Klein, P.S. (1982). Responses of hyperactive and normal children to variations in tempo of background music. Israel Journal of Psychiatry and Related Science, 18, 157–166.

Kreppner, J.M., O'Connor, T.G., & Rutter, M. (2001). Can inattention/overactivity be an institutional deprivation syndrome? Journal of Abnormal Child Psychology, 29, 513–528.

Lahey, B., Applegate, B., & McBurnett, K.E. (1994). DSM-IV field trials for Attention Deficit Hyperactivity Disorder in children and adolescents. American Journal of Psychiatry, 151, 1673–1685.

Lahey, B.B., & Carlson, C.L. (1991). Validity of the diagnostic category of attention deficit disorder without hyperactivity: A review of the literature. Journal of Learning Disabilities, 24, 110–120.

Lawrence, V., Houghton, S., Tannock, R., Douglas, G., Durkin, K., & Whiting, K. (2002). ADHD outside the laboratory: Boys' executive function performance on tasks in videogame play and on a visit to the zoo. Journal of Abnormal Child Psychology, 30, 447–462.

Lee, D.L., & Asplen, J. (in press). The effects of added color on the math performance of children with co-occurring learning disabilities and attention deficits. Journal of Learning Disabilities.

Lee, D.L., & Zentall, S.S. (2002). The effects of visual stimulation on the mathematics performance of children with attention deficit/hyperactivity disorder. Behavioral Disorders, 27, 272–288.

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

Leung, J.P., Leung, P.W.L., & Tang, C.S.K. (2000). A vigilance study of ADHD and control children: Event rate and extra-task stimulation. Journal of Developmental and Physical Disabilities, 12, 187–201.

Leung, P.W.L., & Connolly, K.J. (1996). Distractibility in hyperactive and conduct-disordered children. Journal of Child Psychology and Psychiatry, 37, 305–312.

Levendoski, L.S., & Cartledge, G. (2000). Self-monitoring for elementary school children with serious emotional disturbances: Classroom applications for increased academic responding. Behavioral Disorders, 25, 211–224.

Maag, J.W., Reid, R., & DiGangi, S.A. (1993). Differential effects of self-monitoring attention, accuracy, and productivity. Journal of Applied Behavior Analysis, 26, 329–344.

Malone, M.A., & Swanson, J.M. (1993). Effects of methylphenidate on impulsive responding in children with attention-deficit hyperactivity disorder. Journal of Child Neurology, 8, 157–163.

Marshall, R.M., Hynd, G.W., Handwerk, M.J., & Hall, J. (1997). Academic underachievement in ADHD subtypes. Journal of Learning Disabilities, 30, 635–642.

McGimsey, J.F., & Favell, J.E. (1988). The effects of increased physical exercise on disruptive behavior in retarded persons. Journal of Autism and Developmental Disorders, 18, 167–179.

Meharg, S.S., & Woltersdorf, M.A. (1990). Therapeutic use of videotape self-modeling—A review. Advances in Behaviour Research and Therapy, 12, 85–99.

Meichenbaum, D. (1979). Teaching children self-control. Advances in Clinical Child Psychology, 2, 1–27.

Meyer, M.J., & Zentall, S.S. (1995). Observations of loud behavioral consequences: Attention Deficit Hyperactivity Disorder with and without aggression. Behavior Therapy, 36, 491–509.

Milch-Reich, S., Campbell, S.B., Pelham, W.E., Connelly, L.M., & Geva, K. (1999). Developmental and individual differences in children's on-line representations of dynamic social events. Child Development, 70, 413–431.

Milich, R., & Lorch, E.P. (1994). Television viewing methodology to understanding cognitive processing of ADHD children. Advances in Clinical Child Psychology, 16, 177–201.

Miranda, A., Presentacion, M.J., & Soriano, M. (2002). Effectiveness of a school-based multicomponent program for the treatment of children with ADHD. Journal of Learning Disabilities, 35, 546–562.

Mrug, S., Hoza, B., & Gerdes, A.C. (2001). Children with attention-deficit/hyperactivity disorder: Peer relationships and peer-oriented environments. New Directions for Child and Adolescent Development, 91, 51–76.

The MTA Cooperative Group. (1999). A 14-month randomized clinical trial of treatment strategies for attention deficit/ hyperactivity disorder. Archives of General Psychiatry, 56, 1073–1086.

Paul, J.L., & Epanchin, B.C. (1991). Educating emotionally disturbed children and youth: Theories and practices for teachers. New York: Macmillan.

Prater, M.A., Hogan, S., & Miller, S.R. (1992). Using self-monitoring to improve on-task behavior and academic skills of an adolescent with mild handicaps across special and regular education settings. Education and Treatment of Children, 15, 43–55.

Radosh, A., & Gittelman, R. (1981). The effect of appealing distractors on the performance of hyperactive children. Journal of Abnormal Child Psychology, 9, 179–189.

Rapport, M.D., Denney, C., DuPaul, G.J., & Gardner, M.J. (1994). Attention deficit disorder and methylphenidate: Normalization rates, clinical effectiveness and response prediction in 76 children. Journal of the American Academy of Child and Adolescent Psychiatry, 33, 882–893.

Reid, R. (1999). Attention-deficit hyperactivity disorder: Effective methods for the classroom. Focus on Exceptional Children, 32, 1–20.

Reid, R., Trout, A.L., & Schartz, M. (in press). Self-regulation interventions for children with attention deficit hyperactivity disorder. Exceptional Children.

Richters, J.E., Arnold, L.E., Jensen, P.S., Abikoff, H., Conners, C.K., Greenhill, L.L., et al. (1995). NIMH Collaborative Multisite Multimodal Treatment Study of Children with ADHD: I. Background and rationale. Journal of the American Academy of Child and Adolescent Psychiatry, 34, 987–1000.

Rosenthal, J.H. (1973). Neurophysiology of minimal cerebral dysfunctions. Academic Therapy, 8, 291–294.

Rosenthal, R.H., & Allen, T.W. (1978). An examination of attention, arousal, and learning dysfunctions of hyperkinetic children. Psychological Bulletin, 85, 689–715.

Rosenthal, R.H., & Allen, T.W. (1980). Intratask distractibility in hyperkinetic and nonhyperkinetic children. Journal of Abnormal Child Psychology, 8, 175–187.

Runnheim, V.A., Frankenberger, W.R., & Hazelkorn, M.N. (1996). Medicating students with emotional and behavioral disorders and ADHD: A state survey. Behavioral Disorders, 21, 306–314.

Sagvolden, T., Metzger, M.A., & Sagvolden, G. (1993). Frequent reward eliminates differences in activity between hyperkinetic rats and controls. Behavioral and Neural Biology, 59, 225–229.

Satterfield, J.H., Schell, A.M., Nicholas, T.W., Satterfield, B.T., & Freese, T.E. (1990). Ontogeny of selective attention effects on event-related potentials in attention-deficit hyperactivity disorder and normal boys. Biological Psychiatry, 28, 879–903.

Schweitzer, J.B., & Sulzer-Azaroff, B. (1995). Self-control in boys with attention-deficit hyperactivity disorder: Effects of added stimulation and time. Journal of Child Psychology and Psychiatry, 36, 671–686.

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

Semrud-Clikeman, M., Nielsen, K.H., Clinton, A., Sylvester, L., Parle, N., & Conner, R. (1999). An intervention approach for children with teacher- and parent-identified attentional difficulties. Journal of Learning Disabilities, 32, 581–590.

Sergeant, J.A. (2000). The cognitive-energetic model: An approach to attention deficit hyperactivity disorder. Neuroscience Biobehavioral Review, 24, 7–12.

Shaffer, R.J., Jacokes, L.E., Cassily, J.F., Greenspan, S.I., Tuchman, R.F., & Stemmer, P.J. (2001). Effect of interactive metronome rhythmicity training on children with ADHD. American Journal of Occupational Therapy, 55, 155–162.

Shaw, G., & Brown, G. (1999). Arousal, time estimation, and time use in attention-disordered children. Developmental Neuropsychology, 16, 227–242.

Shroyer, C., & Zentall, S.S. (1986). Effects of rate, nonrelevant information, and repetition on the listening comprehension of hyperactive children. Journal of Special Education, 20, 231–239.

Steinkamp, M.W. (1980). Relationships between environmental distractions and task performance of hyperactive and normal children. Journal of Learning Disabilities, 13, 209–214.

Streett, B.E. (1995). Attention-deficit hyperactivity disorder and conduct disorders. The Counselor, Fall, 23–26.

Swanson, J.M., McBurnett, K., Christian, D.L., & Wigal, T. (1995). Stimulant medication and treatment of children with ADHD. In T.H. Ollendick & R.J. Prinz (Eds.), Advances in clinical child psychology (Vol. 17, pp. 265–322). New York: Plenum Press.

Tannock, R., Schachar, R.J., & Logan, G.D. (1993). Does methylphenidate induce overfocusing in hyperactive children? Journal of Clinical Child Psychology, 22, 28–41.

Tant, J.L., & Douglas, V.I. (1982). Problem solving in hyperactive, normal and reading-disabled boys. Journal of Abnormal Child Psychology, 10, 285–306.

Taylor, A.F., Kuo, F.E., & Sullivan, W.C. (2001). Coping with ADD: The surprising connection to green play settings. Environment and Behavior, 33, 54–77.

Tripp, G., & Alsop, B. (1999). Sensitivity to reward frequency in boys with attention deficit hyperactivity disorder. Journal of Clinical Child Psychology, 28, 366–375.

van der Meere, J., Shalev, R., Borger, N., & Gross-Tsur, T.V. (1995). Sustained attention, activation, and MPH in ADHD: A research note. Journal of Child Psychology and Psychiatry, 36, 697–703.

Vargas, A.U., Zentall, S.S., & Wilbur, J.D. (2002). Responses to art attention-training by English and bilingual Spanish-speaking students with and without ADHD. Studies in Art Education, 43, 158–174.

Varni, J.W., & Henker, B. (1979). Self-regulation approach to the treatment of three hyperactive boys. Child Behavior Therapy, 1, 171–192.

Walker, B.C. (1980). The relative effects of painting and gross-motor activities on the intrinsic locus-of-control of hyperactivity in learning disabled elementary school pupils. Studies in Art Education, 21, 13–21.

Warner-Rogers, J., Taylor, A., Taylor, E., & Sandberg, S. (2000). Inattentive behavior in childhood. Journal of Learning Disabilities, 33, 520–537.

Whalen, C.K., & Henker, B. (1991). Therapies for hyperactive children: Comparisons, combinations, and compromises. Journal of Consulting and Clinical Psychology, 59, 126–137.

Wilens, T.E., Biederman, J., & Spencer, T.J. (2002). Attention deficit/hyperactivity disorder across the lifespan. Annual Review of Medicine, 53, 113–131.

Willcutt, E.G., & Pennington, B.F. (2000). Comorbidity of reading disability and attention-deficit/hyperactivity disorder: Differences by gender and subtype. Journal of Learning Disabilities, 33, 179–191.

Wolraich, M.L., Lindgren, S., Stromquist, A., Milich, R., Davis, C., & Watson, D. (1990). Stimulant medication use by primary care physicians in the treatment of attention-deficit hyperactivity disorder. Pediatrics, 86, 95–101.

Worland, J., North-Jones, M., & Stern, J.A. (1973). Performance and activity of hyperactive and normal boys as a function of distraction and reward. Journal of Abnormal Child Psychology, 1, 363–377.

Zentall, S.S. (1975). Optimal stimulation as theoretical basis of hyperactivity. American Journal of Orthopsychiatry, 45, 549–563.

Zentall, S.S. (1980). Behavioral comparisons of hyperactive and normally active children in natural settings. Journal of Abnormal Child Psychology, 8, 93–109.

Zentall, S.S. (1985). Stimulus-control factors in search performance of hyperactive children. Journal of Learning Disabilities, 18, 480–485.

Zentall, S.S. (1986). Effects of color stimulation on performance and activity of hyperactive and nonhyperactive children. Journal of Educational Psychology, 78, 159–165.

Zentall, S.S. (1988). Production deficiencies in elicited language but not in spontaneous verbalizations of hyperactive children. Journal of Abnormal Child Psychology, 16, 657–673.

Zentall, S.S. (1989a). Attentional cuing in spelling tasks for hyperactive and comparison regular classroom children. Journal of Special Education, 23, 83–93.

Zentall, S.S. (1989b). Self-control training with hyperactive and impulsive children. In J.N. Hughes & R.J. Hall (Eds.), Handbook of cognitive behavioral approaches in educational settings (pp. 305–346). New York: Guilford Press.

Zentall, S.S. (1993). Research on the educational implications of attention deficit hyperactivity disorder. Exceptional Children, 60, 143–153.

Zentall, S.S. (1995). Modifying classroom tasks and environments. In S. Goldstein (Ed.), Understanding and managing children's classroom behavior (pp. 356–374). New York: Wiley.

Zentall, S.S. (in press). ADHD and education: Foundations, characteristics, methods, and consultation. Columbus, OH: Pearson/Merrill/Prentice Hall.

Zentall, S.S., Cassady, J.C., & Javorsky, J. (2001). Social comprehension of children with hyperactivity. Journal of Attention Disorders, 5, 11–24.

Zentall, S.S., & Dwyer, A.M. (1988). Color effects on the impulsivity and errors of hyperactive children. Journal of School Psychology, 27, 165–174.

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

Zentall, S.S., & Gohs, D.E. (1984). Hyperactive and comparison children's response to detailed vs. global cues in communication tasks. Learning Disability Quarterly, 7, 77–87.

Zentall, S.S., & Goldstein, S. (1999). Seven steps to homework success: A family guide for solving common homework problems. New York: Specialty Press.

Zentall, S.S., Grskovic, J., Javorsky, J., & Hall, A.M. (2000). Effects of noninformational color on reading test performance of students with attention deficit hyperactivity disorder (ADHD). Diagnostique, 25, 129–146.

Zentall, S.S., Hall, A.M., & Lee, D.L. (1998). Attentional focus of students with hyperactivity during a word-search task. Journal of Abnormal Child Psychology, 26, 335–343.

Zentall, S.S., & Javorsky, J. (1995). Functional and clinical assessment of ADHD: Implications of DSM-IV in the schools. Journal of Psychoeducational Assessment, ADHD Special Monograph, 22–41.

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

Zentall, S.S., & Meyer, M. (1987). Self-regulation of stimulation for ADD-H children during reading and vigilance task performance. Journal of Abnormal Child Psychology, 15, 519–536.

Zentall, S.S., & Shaw, J.H. (1980). Effects of classroom noise on performance and activity of second-grade hyperactive and control children. Journal of Educational Psychology, 72, 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, 693–697.

Zentall, S.S., & Zentall, T.R. (1983). Optimal stimulation: A model of disordered activity and performance in normal and deviant children. Psychological Bulletin, 94, 446–471.

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

Zentall, S.S., Zentall, T.R., & Booth, M.E. (1978b). Within-task stimulation: Effects on activity and spelling performance in hyperactive and normal children. Journal of Educational Research, 71, 223–230.

Zimmerman, B.J. (2001). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P.R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp. 13–41). San Diego, CA: Academic Press.