COPING WITH ADD
The Surprising Connection to Green Play Settings

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ABSTRACT: Attention Restoration Theory suggests that contact with nature supports attentional functioning, and a number of studies have found contact with everyday nature to be related to attention in adults. Is contact with everyday nature also related to the attentional functioning of children? This question was addressed through a study focusing on children with Attention Deficit Disorder (ADD). This study examined the relationship between children's nature exposure through leisure activities and their attentional functioning using both within- and between-subjects comparisons. Parents were surveyed regarding their child's attentional functioning after activities in several settings. Results indicate that children function better than usual after activities in green settings and that the "greener" a child's play area, the less severe his or her attention deficit symptoms. Thus, contact with nature may support attentional functioning in a population of children who desperately need attentional support.

Over 2 million children in the United States alone are struggling to cope with a chronic attentional deficit, Attention Deficit Disorder (ADD) (Barkley,

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1995).[1] ADD reduces children's attentional capacity and in doing so, has detrimental effects on many aspects of life (e.g., school, interpersonal relationships, personal growth). Unfortunately, of the available treatments, some have costly side effects, and the remaining have limited effectiveness. Surprisingly, the physical environment has not been examined as a potential source of support for children with ADD. Attention Restoration Theory (Kaplan, 1995) proposes that nature may support attentional functioning, and a growing body of evidence indicates that, in adults with regular attentional capacity, nature is supportive of attentional functioning. Could natural environments support attentional functioning in children with attention deficits? The study presented here examined the effects of children's afterschool and weekend activity settings on their attention deficit symptoms.

In this section, we describe ADD and its treatment, review the previous work on nature and attention, and present the central questions motivating this study.

ATTENTION DEFICIT DISORDER

Attention Deficit Disorders are surprisingly common and have far reaching consequences. ADD occurs in about 3% to 7% of school-age children (Barkley, 1997; Bender, 1997; Hinshaw, 1994). Moreover, there is substantial evidence that ADD in childhood can disrupt cognitive and social development in several pivotal areas. First, children with ADD tend to have poor academic performance (for reviews, see Barkley, 1997; Bender, 1997; Hinshaw, 1994). Second, they are at increased risk for problems in the social arena as well. For example, they tend to have poor peer relationships and are often rejected by their peers (Alessandri, 1992; for reviews, see Bender, 1997; Berk, 1994; Hinshaw, 1994). They also tend to have poor relations with their parents and have a higher rate of family conflict (Barkley, Anastopoulos, Guevremont, & Fletcher, 1992). In addition, children with ADD tend to display more aggressive and antisocial behavior (for reviews,

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see Barkley, 1997; Hinshaw, 1994). Perhaps it is not surprising, then, that children with ADD are often also at greater risk for low self-esteem, anxiety, and depression (for reviews, see Barkley, 1997; Bender, 1997; Hinshaw, 1994).

ADD is essentially defined as a developmental lag in the specific area of attentional control. Thus, diagnosis involves evaluating a child's attentional control relative to their same-age peers (American Psychiatric Association, 1994). Specifically, the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)* defines ADD as a persistent pattern of inattention "that is more frequent and severe than is typically observed in individuals at a comparable level of development" (American Psychiatric Association, 1994, p. 78). Barkley (1998) suggests that children with ADD can be expected to display attentional control at a level 30% behind their same-age non-ADD peers; for example, a 10-year-old ADD child generally displays behaviors more typical of a 7-year-old child.

Current evidence suggests that this lag in attentional development is due to biological factors (Barkley, 1995; Shue & Douglas, 1992). For example, physiological recordings obtained through magnetic resonance imaging show physical differences in the brain morphology of children with ADD. Specifically, the right frontal lobe, which plays a key role in directed attention (Foster, Eskes, & Stuss, 1994), was found to be smaller in children with ADD (Hynd, Semrud-Clikeman, Lorys, Novey, & Eliopulos, 1990) than in children with age-appropriate attentional control. Thus, although folk theory holds that the immaturity of behaviors in ADD children is the product of social factors such as poor parenting, the evidence suggests that ADD is a biologically based disorder and not the product of the social or physical environment (Barkley, 1998; National Institute of Mental Health [NIMH], 1994).

HOW IS ADD TREATED?

Current treatments for ADD are limited in effectiveness and have many shortcomings (for reviews, see Fiore, Becker, & Nero, 1993; Hinshaw, 1994). Stimulant medications, such as Ritalin, Dexedrine, and Cylert, are the primary treatment for ADD (Hinshaw, 1994; NIMH, 1994; Swanson et al., 1993). In 9 out of 10 children, these medications help sustain attention and provide temporary gains in academic productivity (NIMH, 1994), but unfortunately, they fail to improve children's long-term social and academic outcomes (for review, see Hinshaw, 1994). In addition, these medications have serious side effects. They often suppress appetite and disrupt sleep (Hinshaw, 1994; NIMH, 1994), and in some children, they induce extreme depression and unusually flattened affect (Douglas, 1972).

Behavioral therapies are a second form of treatment for ADD. These include direct contingency management, in which children earn or lose points for specific behaviors, and cognitive behavioral procedures, in which children learn how to self-monitor attention and impulsive behavior (for review, see Fiore et al., 1993; Hinshaw, 1994). Unfortunately, these therapies are typically not sufficient to bring children into normal ranges of functioning (Fiore et al., 1993; Hinshaw, 1994).

Given the difficulties associated with medication and behavior therapy-based treatments, there is a clear need to explore alternative means of treating ADD. Could contact with nature support the attentional functioning of children who have ADD? Both theory and evidence regarding the relationship between contact with nature and attentional functioning suggest it might.

NATURE AND ATTENTION

Attention Restoration Theory (Kaplan, 1995) proposes that natural environments can assist attentional functioning. To understand how this might be so, let us review James's (1892/1962) theory of attention, and then Kaplan's (1995) application of that theory to Attention Restoration Theory.

James proposed that humans have two types of attention: voluntary and involuntary. Voluntary attention, or what Kaplan (1995) calls directed attention, is the kind of attention we use when we deliberately pay attention. This form of attention is employed in attending to tasks (e.g., problem solving) or situations (e.g., driving in heavy traffic) that require sustained attention and that are not inherently easy to attend to. After prolonged and intense use, directed attention becomes fatigued (Glosser & Goodglass, 1990; Kaplan, 1995). By contrast, involuntary attention is easy and does not require effort (James, 1892/1962). James suggested that certain elements in the environment draw on our involuntary attention: "strange things, moving things, wild animals, bright things, pretty things, words, blows, blood, etc. etc. etc." (James, 1892/1962, p. 231). Reliance on involuntary attention can be useful for the rest and recovery of fatigued directed attention. Kaplan (1995) proposes that stimuli and environments that draw primarily on involuntary attention give directed attention a chance to rest. Attention Restoration Theory suggests that natural environments assist in recovery from directed attention fatigue in part because they draw on involuntary attention rather than directed attention (Kaplan, 1995).

A number of studies in adult populations support Attention Restoration Theory. Several studies have shown that nature draws on involuntary attention (e.g., Kaplan, 1973, 1983; Kaplan & Talbot, 1983; Ulrich, 1981). In

addition, a number of other studies have shown that exposure to natural environments can be effective in restoring directed attention from fatigue (Canin, 1991; Cimprich, 1990; Hartig, Mang, & Evans, 1991; Kuo, in press; Lohr, Pearson-Mims, & Goodwin, 1996; Miles, Sullivan, & Kuo, 1998; Ovitt, 1996; Tennessen & Cimprich, 1995). In one study, exposure to natural environments through leisure activities was shown to be related to attentional functioning in adults. A study of AIDS caregivers found that nature activities and quiet activities were associated with robust attentional functioning, whereas activities such as TV watching, shopping, and watching or playing organized sports were associated with poorer attentional functioning (Canin, 1991).

NATURE AND ATTENTION IN CHILDREN

Could contact with nature support attention in children? Theoretical and empirical work in landscape architecture and environmental psychology has addressed numerous possible other benefits of nature for children, including providing privacy, mental stimulation, and sensory stimulation and supporting important developmental activities such as play, creative forms of play, and exploratory and divergent thinking (Heseltine, 1987; Jansson, 1984; Kirkby, 1989; Miller, 1972; Moore, 1986, 1989; Nabhan & Trimble, 1994; Senda, 1992; Striniste & Moore, 1989; Taylor, Wiley, Kuo, & Sullivan, 1998; Trancik & Evans, 1995). Only one article has raised the question of nature's potential impacts on children's attention (Trancik & Evans, 1995). Trancik and Evans (1995) suggest that the design of day care settings should include spaces supporting "restoration," such as natural areas, because preschool children may be susceptible to mental fatigue as they adapt to a new preschool environment. However, this idea has not been empirically examined.

There are reasons to think that Attention Restoration Theory extends to children. Like adults, children may become attentionally fatigued. For example, children's schoolwork requires extended periods of deliberate, effortful attention. And like adults, children often must carry out these tasks in a context filled with powerful distractions that constantly demand attention, making it extremely difficult to concentrate on the task at hand. In addition, because children's attention is not fully developed (Mackworth, 1976; Shaffer, 1985), they may be fighting off distractions with less attentional control than adults. Thus, children may need attentionally supportive environments where they can go to restore. It seems plausible that natural environments might support attention in children, including children with ADD.

This study examined whether contact with nature assists attentional functioning in children with ADD. Two hypotheses were formulated and tested: one regarding the immediate aftereffects of contact with nature, and the other regarding the general effects of nature on the severity of a child's ADD symptoms. Specifically, we proposed that

Hypothesis 1: Attention deficit symptoms will be more manageable after activities in green settings than after activities in other settings.
Hypothesis 2: The greener a child's everyday environment, the more manageable their attention deficit symptoms will be in general.

To address these hypotheses, we conducted a survey of parents of children with ADDs. For each child, we collected information about the aftereffects of leisure activities conducted in different settings, the amount of nature in their everyday environment, and the severity of their symptoms in general. In addition, six possible alternative explanations for a nature-attention relationship were examined.

METHOD

The questionnaire and procedures for this study were developed through a multifaceted qualitative data collection effort. The methodology was guided by interviews with children with ADD, their parents, and a variety of professionals with expertise in ADD (pediatricians, a professor of special education, and a fifth-grade teacher). The methodology was also guided by classroom observations of four ADD children (10-11 years old).

The questionnaire was pretested with four different families, one family at a time. As parents completed each section of the questionnaire, the following concerns were addressed: (a) whether the activities included in the survey adequately covered the range of activities 7- to 12-year-olds engage in, (b) whether parents understood the concept of post-activity attentional functioning, (c) whether the rating scales were appropriate, and (d) whether the nature measures were easily interpretable and usable. After each pretest, revisions were made to the questionnaire before further pretesting.

It is worth noting that an effort was made to develop a questionnaire for the ADD children themselves; however, pretesting indicated that the children were not able to reliably report on any aftereffects of their activities on their attention deficit symptoms.

QUESTIONNAIRE

The final version of the questionnaire was printed as a small booklet that took about 30 to 40 minutes to complete. On the cover, the following narrative introduced participants to the idea that children's activities might have aftereffects on their attention.

> Think about how you feel after a difficult week. You may find it more difficult than usual to pay attention. On the other hand, after a good vacation, you may find that it's relatively easy to focus your attention.
>
> We suspect that the same may be true for children. There are many different ways children can spend their time outside of school. For children with attention deficits, it's possible that some activities leave children functioning better than usual, while other activities leave children in worse shape.
>
> In other words, perhaps during the hour or so *after* your child does a certain activity, you find that their ADD/ADHD symptoms are worse than usual. Or vice versa; perhaps *after* doing another activity, you find that your child is functioning better than usual.

To make the concept *attentional functioning* more concrete, four specific attention deficit symptoms were listed:

- Can't stay focused on unappealing tasks (homework or chores)
- Can't complete tasks
- Can't listen and follow directions
- Easily distracted

These symptoms are modified selections from the diagnostic criteria for Attention Deficit/Hyperactivity Disorder (pp. 83-84 of *DSM-IV*; APA, 1994). Because Attention Restoration Theory suggests a relationship between nature and attentional functioning, but not necessarily between nature and hyperactivity-impulsivity, only symptoms of *inattention* were selected. In addition, because parents rarely observe their children in the classroom, only symptoms readily apparent in a home setting were presented.

In the first section of the questionnaire, participants were asked to nominate up to two afterschool and weekend activities that they felt left their child functioning especially well and up to two activities that they felt left their child functioning especially poorly. Parents completed the sentence, "After ____ my child's ADD symptoms are much *less* noticeable than usual. My child is in good shape." Parents were asked to nominate up to two best activities. Parents then did the same for worst activities: "After ____ my

child's ADD symptoms are much *more* noticeable than usual. My child is in bad shape." For both items, parents had the option of marking *none*, if they had not noticed any activities that were particularly helpful or harmful for their child's attention. About 66% of parents were able to nominate at least one activity that was best for their child; 68% were able to nominate at least one that was worst. Parents' nominations were later coded in terms of their likely settings by an individual blind to the best and worst labels. Each of the activities was classified as either Green (likely to take place in a relatively natural setting), Not Green (unlikely to take place in a relatively natural setting), or Ambiguous (ambiguous with respect to physical setting). For example, camping trip, fishing, and soccer were coded as Green, whereas video games, TV, and homework were coded as Not Green. Activities such as playing outside and rollerblading were coded as Ambiguous.

In the second section, participants were presented with a list of afterschool and weekend activities and asked to rate each activity in terms of any aftereffects of that activity on their child's attention deficit symptoms. These postactivity attentional functioning ratings, or PAAF ratings, were made on a 5-point Likert-type scale from 1 = *much worse* to 5 = *much better*, with a midpoint of 3 = *same as usual*; *don't know* was also an option. Twenty-five activities were presented in three lists: 11 activities conducted indoors, 6 activities conducted in built outdoor spaces (defined as mostly human-made areas—parking lots, downtown areas, or just a neighborhood space that doesn't have much greenery), and 8 activities conducted in green outdoor spaces (defined as mostly natural areas—a park, a farm, or just a "green" backyard or neighborhood space). Each activity was rated for two social contexts: after the activity was conducted alone, or with one person, and after the activity was conducted with two or more people.

In the final section of the questionnaire, parents answered a series of general questions about their child, their household, and the child's everyday surroundings. Parents answered the question, In general, how severe would you say your child's ADD or ADHD symptoms are (when not on medication)? using a 5-point Likert-type scale, from 1 = *very mild* to 5 = *very severe*. They reported their child's age, sex, grade in school, diagnoses other than ADD/ADHD, number of adult caregivers, and the household income. In addition, parents assessed the greenness of their child's everyday surroundings.

To assist parents in assessing the level of nature in their child's everyday surroundings, parents were first presented with a set of six photo pairs of possible play settings ranging from *places indoors where it feels very much indoors* (two photos of windowless rooms) to *places where there might be "wild" things: flowers, trees, animals, etc*. (two photos of relatively untamed landscapes). The photo pairs were independently rated by 21 horticulture

students for greenness or naturalness on a scale of 1 = low to 10 = high), with an interrater reliability of .994. To avoid collecting information about play spaces used during other seasons (e.g., winter), parents were asked to select one photo pair description as representative of where their child played during the previous week. Parents were then asked whether their child's activities in the previous week were representative of their normal routine (yes/no).

In addition to assessing the level of nature in their child's typical play settings, parents were asked to assess the overall greenness of their family's residence, the amount of tree cover in their yard, and the amount of grass in their yard. Overall greenness around the home was rated on a 5-point Likert-type scale (1 = *not at all green*, 5 = *very green*). To assess tree cover, parents were shown four photos depicting yards with different levels of tree cover and asked to select one that best represented the amount of tree cover in their front yard and one that best represented the amount of tree cover in their back yard. The amount of grass was measured through the same procedure.

PARTICIPANTS AND PROCEDURE

Participation was limited to parents or legal guardians of children 7 to 12 years old who had been formally diagnosed with ADD or ADHD (i.e., diagnosed by a physician, psychologist, or psychiatrist).

Participants were recruited through flyers distributed to pediatricians' offices, medical clinics, schools, and parent support groups such as Children and Adults with Attention Deficit/ Hyperactivity Disorder (CHADD). Participants were also recruited through advertisements placed in major newspapers. Newspaper advertisements were restricted to the midwestern United States to ensure roughly comparable climate and vegetation across the sample. The flyers and advertisements invited parents to participate in a mail-back or Internet-based survey about the effects of ADD/ADHD children's afterschool and weekend activities on their symptoms. Two incentives were offered: a list of recommendations based on the study's findings and a choice of a pizzeria gift certificate or a children's book about ADD.

Questionnaire data were collected, as suggested by a pediatrician and special education professor, when the attentional demands of school would make potential effects of nature on attention most salient to parents. Data were collected from mid-September, after children's school routines were well established, through the end of October, before inclement weather might significantly limit outdoor play. Paper copies of the questionnaire were mailed to parents who volunteered by phone or by e-mail, and an electronic version of the questionnaire was also made available on the Internet. The Dillman (1978) follow-up methodology was employed to encourage participants to

return the mail-back questionnaire within the time frame of the study. By the deadline, 77 paper copies of the questionnaire were returned, or 58% of those mailed. An additional 19 questionnaires were completed on the Internet, for a total of 96 completed questionnaires.

Given the use of convenience sampling, it is important to note that this sample was similar to other samples of children with ADDs. The ratio of boys to girls with attention deficits in the general population is estimated to be 3:1 (Barkley, 1990; Bender, 1997) or even 4:1 (American Psychiatric Association, 1994); the ratio of boys to girls in this sample was 3:1. Overall, this sample had more children with ADHD (61%) than ADD (39%). The ratio of ADD to ADHD in the general population is estimated at 1:1.7 for boys and 1:2.2 for girls (Szatmari, Offord, & Boyle, 1989); the ratio of ADD to ADHD in this sample was 1:1.6 for boys and 1:1.5 for girls. The percentage of ADD or ADHD boys having at least one comorbid disorder in the general population is 44%, whereas 29% of girls have at least one comorbid disorder (Szatmari et al., 1989); in our sample, 52% of boys had one comorbid disorder, and 36% of girls had one comorbid disorder. The mean age of children in this sample was 9.4 years, with a standard deviation of 1.5 years. About 63% of the parents reported their household income to be $50,000 or greater.

After the questionnaire data from the complete sample were analyzed, a subset of questionnaire participants was invited to a focus group dinner to discuss the findings. Eight questionnaire participants who had indicated interest in a follow-up interview attended. Focus group participants first briefly reacquainted themselves with the questionnaire and were asked to discuss any parts of the questionnaire they had found difficult to understand or complete. They were then asked if they had any guesses about the central hypothesis of the study, or "what the study was after." Some of the major findings were then presented, and participants were asked to describe any experiences they had had related to each of these findings, either in keeping with the findings or in contrast to the findings. Finally, participants were asked to describe their observations regarding different activities, different activity settings, and their aftereffects on their children's symptoms

RESULTS

Does contact with nature assist attentional functioning in children with ADD? First, we present tests of the central hypotheses, along with relevant quotes and anecdotes from interviews with parents. Then, we present tests of several alternative explanations for the central findings.

TABLE 1
Activities Nominated as Best and Worst for Attention Deficit Disorder Symptoms, Classified by Likely Setting

Likely Setting	*Best*	*Worst*
Green (e.g., fishing, soccer)	85% (17)	15% (3)
Ambiguous (rollerblading, playing outside)	56% (43)	44% (34)
Not Green (video games, TV)	43% (53)	57% (69)

NOTE: Numbers in parentheses are *n*s for each group.

TESTING OF CENTRAL HYPOTHESES

Each of the two central hypotheses was tested in multiple ways. Tests of the first hypothesis involved within subjects comparisons; tests of the second hypothesis involved between subjects comparisons.

Hypothesis 1. The first hypothesis was that attention deficit symptoms will be more manageable after activities in green settings than after activities in other settings. This hypothesis was first tested by examining the activities nominated by parents as particularly helpful (best) or harmful (worst) for their children's attention deficit symptoms: 113 best activities and 106 worst activities were nominated. If green settings are more attentionally supportive, then activities typically conducted in green settings should be overrepresented among the activities nominated as best and underrepresented among the activities nominated as worst. Indeed, as Table 1 shows, of the 20 Green activities (activities judged by an independent coder as likely to take place in a relatively natural setting), 17 were nominated as best, and 3 were nominated as worst (85% vs. 15%). Furthermore, Not Green activities were overrepresented among the activities nominated as worst (57%; 43% best). A chi-square confirmed that the likelihood that an activity would be nominated as best or worst significantly differed for different settings, $\chi^2(2) = 12.74$, $p < .01$. This finding raises the possibility that participants nominated Green activities as best because they had guessed the central hypothesis of the study. However, during the focus group, questionnaire participants said they had not guessed that the study was about the relationship between nature and attention.

The first hypothesis was then tested by examining parents' ratings of their children's attention deficit symptoms after participating in various activities in one of three settings. The mean PAAF rating for all activities was 3.22 (between 3 = *same as usual* and 4 = *better than usual*) with a standard deviation of .48. Mean PAAF ratings for specific activities ranged from 2.14, for homework with others indoors, to 3.80, for riding bike alone in green set-

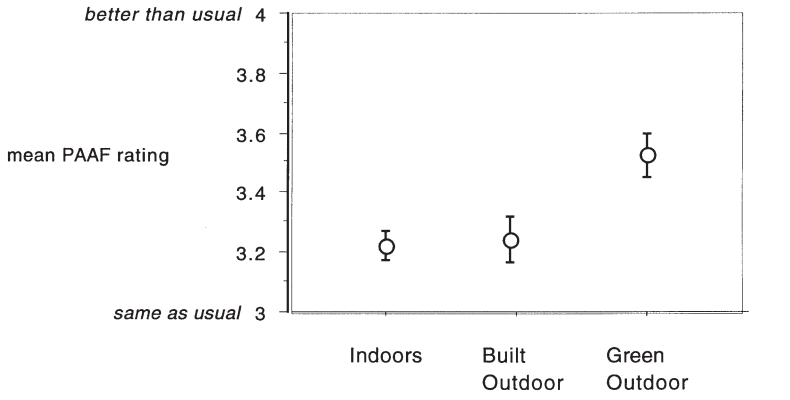

Figure 1: Mean Postactivity Attentional Functioning Ratings for Indoor, Built Outdoor, and Green Outdoor Activities

tings. If nature is supportive of ADD children's attentional functioning, activities conducted in green outdoor settings should receive higher PAAF ratings, on average, than activities conducted in indoor settings or built outdoor settings. In fact, a repeated measures ANOVA indicates that PAAF ratings do differ by setting, $F(2, 82) = 15.51$, $p < .0001$ (see Figure 1). Green activities received a significantly higher PAAF rating on average than indoor activities, Fishers PLSD $d = .30$, $p < .0001$, ($M = 3.53$ versus 3.22, respectively) and a significantly higher rating than built outdoor activities, Fishers PLSD $d = .28$, $p < .0001$, ($M = 3.53$ versus 3.24, respectively).

In the comparison of PAAF ratings for indoor versus green outdoor settings reported above, homework was included as one of the indoor activities because it constitutes an important afterschool and weekend indoor activity. However, whereas the other activities rated in the survey are truly leisure activities, homework is not a leisure activity, and is particularly attentionally demanding. Thus, it seems unfair to compare indoor activities to outdoor activities with homework included as an indoor activity. Hence, we compared PAAF ratings for indoor versus green outdoor activities, excluding homework from the analysis. Even with homework excluded, the pattern held, with green outdoor activities still receiving significantly greater PAAF scores than indoor activities, Fisher's PLSD $d = .25$, $p = .0001$.

The aftereffects of activities on children's attention deficit symptoms were further explored in the focus group. Participants were asked if they had had any experiences, either positive or negative, related to any aftereffects of green settings on their child's attention. One parent said she had recently begun taking her son to the local park for 30 minutes each morning before

school because the weather was nice, and they "had some time to kill." She then said,

> Come to think of it, I have noticed his attitude toward going to school has been better, and his school work has been better this past week. I think it's because spending time at the park is pleasurable, peaceful, quiet, calming.

Another parent suggested that his son, although usually struggling against his attention deficit symptoms, can "hit golf balls with me for 2 hours at a time," and "he fishes for hours at a time alone." This father reported that, after these activities, his son's attention deficit symptoms "are minimal," and "he's very relaxed." "When I read the results of your study, they hit me in the face," continued this parent. "I thought, yes I've seen this!" (referring to the positive effects of nature on ADD children's attentional functioning). In contrast, none of the focus group participants could report any instances in which green outdoor activities exacerbated their child's attention deficit symptoms.

Hypothesis 2. The second central hypothesis in this study was that the greener the child's everyday environment, the more manageable their attention deficit symptoms will be in general. This hypothesis was first tested by examining the relationship between the greenness of the child's play setting during the previous week and the severity of their attention deficit symptoms. The mean rating of children's overall severity of symptoms fell between average and severe ($M = 3.53$, range = 1-5). Many (39%) were rated as having average severity of symptoms, whereas half (50%) had symptoms that were rated as severe or very severe. Most parents reported that their children played in places with big trees and grass (44%), or indoor places without windows (16%), or places where there is a lot of open grass (13%). If greenness of play environment affects attentional functioning, then children who play in greener settings should receive lower severity of symptoms ratings. Indeed, a regression analysis between horticulture students' greenness ratings of the play setting categories and parents' severity of symptoms ratings revealed a significant positive relationship, $R^2 = .08$, $F(1, 91) = 8.18$, $p < .01$. The greener the child's play environment during the previous week, the less severe their symptoms.

Does this relationship hold when children were excluded from the analyses if their play environments during the previous week was atypical of their usual play environments? Yes, the relationship still held; $R^2 = .06$, $F(1, 70) = 4.48$, $p < .05$.

To further explore this relationship, Figure 2 shows the mean severity of ADD symptoms associated with different play settings, excluding the built

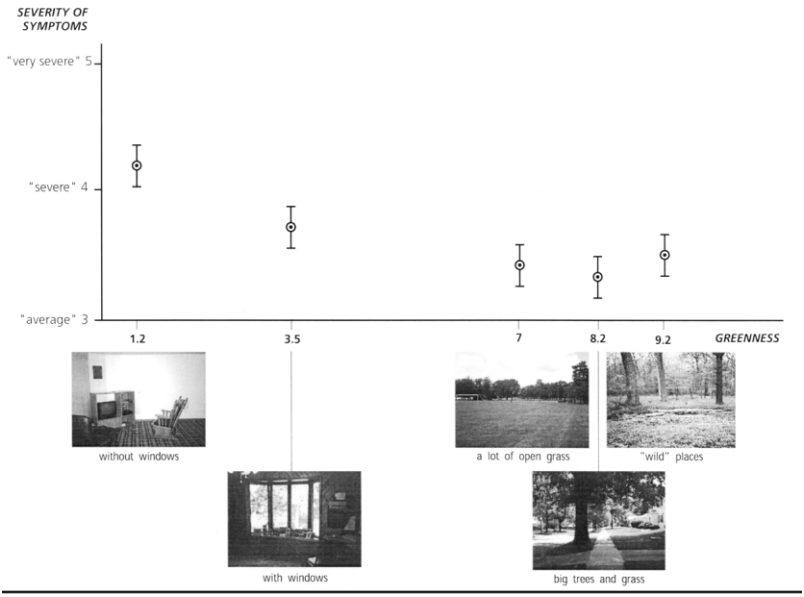

Figure 2: Mean Severity of Attention Deficit Symptoms for Five Play Settings

outdoors setting due to the few children in that category. The pattern of means reinforces the regression findings. In addition, the pattern of means raises the intriguing possibility that indoor settings *with* windows may be more supportive than indoor settings *without* windows and that there are minimal differences between open grassy settings and settings that include trees.

This hypothesis was also examined by testing for a relationship between various measures of residential greenness and the overall severity of symptoms. Most children's residential surroundings (overall greenness) were rated as being quite green ($M = 4.26$, on a 5-point scale). Most children had a large area of grass in their front yard and in their back yard ($M = 2.91$ and 3.27, respectively, on a 1 to 4-point scale). Children also had large amounts of tree cover in front and in back of their homes ($M = 2.92$ and 3.15, respectively, on a 4-point scale). Based on our second hypothesis, children who live in residential areas rated as highly green should receive lower overall severity of symptoms ratings than children who live in less green residential settings. However, we did not find this to be the case; regression analyses indicate that measures of overall greenness, grass cover, and tree cover in the front and back yards were not significantly related to severity of symptoms.[2]

Given that three measures of nature were found to be related to attention, why didn't we find a relationship between residential nature and severity of

symptoms? One possible explanation is that the children in this sample do not gain much exposure to the nature surrounding their homes. It is plausible that these children do not spend much time in their yards, especially because there was such a clear, significant relationship between the greenness of where they played and the severity of their symptoms. The fact that most of the sample (75%) were boys may explain the nonsignificant relationship between residential nature and these children's attentional functioning (severity of symptoms). Interviews with parents during pretesting, as well as comments from the focus group, indicate that boys rarely play in their own yards; they generally choose to play elsewhere.

The effects of extended contact with nature on overall severity of symptoms were further explored in the focus group. Parents were asked, "Has anyone taken your ADD child on a 'pure' nature experience, such as camping, hiking, fishing, biking, etc. in a State park, National park, or other natural area? If so, what happened? Anything memorable?" One parent's response was "Pure nature vacations are the only vacations we *can* take! Theme parks are a nightmare. Two weeks camping in a pop-up camper is just bliss. We have a great time. He's great."

TESTING OF ALTERNATIVE EXPLANATIONS

The findings above indicate that there is a relationship between nature and attentional functioning in children with ADD. This is consistent with Kaplan's theory that contact with nature leads to attentional restoration. Might it be, however, that the correlations reported above were obtained in the absence of any real relationship between nature and attentional functioning? In other words, does the nature-attention relationship exist merely because both nature activities and attentional functioning are related to some other, third, factor? In search of a potential third factor, six alternative hypotheses are considered below.

First, could it be that green activities enhance attentional functioning not because they are green, but because they are conducted outdoors? If so, we would expect that green outdoor activities and built outdoor activities to have average PAAF scores that would not differ significantly. However, a paired t test examining differences in PAAF scores between green outdoor activities and built outdoor activities indicates that green activities received significantly higher average PAAF scores than built outdoor activities, $t(82) = 4.38$, $p < .0001$ ($M = 3.54$ versus 3.24, respectively). Not only did built outdoor activities receive lower PAAF scores than green outdoor activities, but a paired t test indicates that built outdoor activities' PAAF scores are not significantly greater than indoor activities' PAAF scores, $t(82) = .29$, $p = .77$, ($M =$

3.24 and 3.24, respectively). Thus, green activities' relationship to attention cannot be explained by green activities taking place outdoors.

Second, could it be that green activities enhance attentional functioning not because they are green but because they are conducted in a particular social context, either alone or with one person, or with larger groups? If so, we would expect that when social context is controlled, the physical environment in which an activity takes place would have no effect on attention deficit symptoms. A 2×2 (2 physical settings $\times$ 2 social contexts) repeated measures ANOVA indicates that green outdoor activities received higher PAAF scores, on average, than did indoor activities, $F(1, 85) = 44.69$, $p < .0001$, or built outdoor activities, $F(1, 72) = 13.04$, $p < .01$. Furthermore, no interaction was found between physical setting and social setting in either of these analyses. Thus, the social environment cannot explain the relationship between PAAF scores and green settings.

Third, could it be that green activities enhance attentional functioning not because they are green, but because they are physically active? If so, we would expect that physically active green outdoor activities would receive higher PAAF scores than passive green activities. To examine this possibility, an independent coder coded all the activities as active or passive. For example, reading books or magazines and creative activities were coded as passive, whereas bike, skate or skateboard, explore, climb tree, or play in tree houses were coded as active. A paired t test indicates no significant difference between PAAF scores of active and passive activities done in green settings, $t(83) = 1.13$, $p = .26$. Thus, green activities' relationship to attention cannot be explained by green activities being either active or passive.

Fourth, could it be that green activities enhance attentional functioning not because they are green, but because these activities are qualitatively different from activities done in other settings? Could it be that the activities we selected to measure PAAF for green outdoor settings happen to be uniquely supportive of attentional functioning whereas the activities selected for the indoor and built outdoor settings are uniquely unsupportive of attentional functioning, thus making the differences found not due to setting but due to the activities themselves. If so, we would expect that we would not find setting differences when comparing PAAF ratings for a single set of activities after a child does the activities in each of the three settings. The activities matched across setting were creative activities (art, music, models, Legos, collections, etc.), pretending (house, action figures, Power Rangers, etc.), and organized sports. A repeated measures ANOVA comparing three different physical settings and controlling for two social settings indicates that attentional functioning differs systematically by physical setting, $F(2, 62) = 3.06$, $p = .05$. Moreover, paired comparisons indicated that the same

activities, when conducted in green outdoor settings, were associated with better attentional functioning than when they were conducted in either built outdoor settings or indoor settings, $F(1, 63) = 6.17$, $p < .05$, and $F(1, 81) = 4.14$, $p = .05$, respectively). Thus, the differences in attentional functioning between green activities and activities conducted in other settings seem to be due to setting rather than activity.

Fifth, could it be that green activities enhance attentional functioning not because they are green but because they are preferred? If this is the case, then preferred activities should be attentionally supportive. Consistent with this idea, attentionally supportive activities were indeed preferred; a *t* test indicated that the mean preference rating for activities nominated as attentionally best for ADD children was significantly greater than 3.0 (a neutral preference rating), $t(62) = 29.70$, $p < .0001$ ($M = 4.70$). However, preferred activities were also nominated as attentionally worst for ADD children, $t(64) = 3.03$, $p < .01$ ($M = 3.45$). Thus, worst activities were preferred as well as best activities. Both means are more positive than neutral. Thus, preference does not appear to be responsible for making an activity attentionally supportive, and the relationship between green activities and attention cannot be explained by green activities being preferred.

Finally, could it be that some activities are more supportive of attentional functioning because they coincide with medicated periods? Although our data do not permit a direct test of this possibility, we can test for a relationship between medication effects and activities nominated as best and worst. If medication effects are related to activities being nominated as attentionally supportive, then we would expect best activities to have been conducted while a child was medicated and worst activities to have been conducted while a child was unmedicated. However, parents' reports indicate that most activities (64%) nominated as best occur while medications are no longer effective (the dose has worn off). Conversely, 54% of activities nominated as worst occur while medications are still effective. Thus, the relationship between green activities and attention cannot be explained by green activities coinciding with medicated periods.

These analyses indicate that of the six alternative explanations tested, none could explain the nature-attention relationship found.

DISCUSSION

Does nature support attentional functioning in children with ADDs? Several analyses suggest that contact with nature is systematically related to less-

ened attention deficit symptoms. Activities nominated as helpful in reducing attention deficit symptoms were disproportionately likely to take place in green outdoor settings. Conversely, activities nominated as exacerbating symptoms were disproportionately likely to take place in non-green outdoor settings. Parent ratings of PAAF were also systematically higher, on average, for activities conducted in green outdoor settings than for activities conducted in either built outdoor or indoor settings. Although the greenness of a child's residential setting was unrelated to the severity of their ADD symptoms, the greenness of their play setting was related to symptom severity; ADD symptoms were milder for those children with greener play settings. Children who played in windowless indoor settings had significantly more severe symptoms than children who played in grassy outdoor spaces with or without trees did.

Multiple alternative explanations for these findings were tested. The relationship between nature and attention could not be explained by confounds between contact with nature and any of the following factors: being outdoors, social environment, amount of physical activity, types of activity, preference for nature, or timing of medication.

Although these findings are based on correlational data, the design of this study provides more support for a causal interpretation than is typical for correlational work. First, most correlational work gives no confidence in the temporal order of the relationship found, establishing only that A is related to B. This study not only establishes a strong nature-attention relationship, it also suggests a direction to that relationship. Because this study specifically focuses on attentional functioning *after* activities, it seems more plausible that participation in green activities causes improved attentional functioning than that improved attentional functioning causes participation in green activities. Remember that parents had the option of indicating that their child's attentional functioning was the same as usual, if indeed the child did not improve after the activities. Second, most correlational work involves between-subjects comparisons, in which individual differences may account for the findings. This study establishes a strong nature-attention relationship within subjects. We found that green activities are associated with better attentional functioning within the same individual. Such within-individual fluctuations in attentional functioning cannot be accounted for by between-individual differences such as intelligence or wealth. Moreover, the combination of between- and within-subjects comparisons in this study overcomes the limitations of a within-subjects comparison alone. For example, parents might rate their child as functioning better attentionally after activities in green settings simply because they believe spending time in green settings is good for children. This would explain the within-subjects findings

but not the between-subjects findings. Thus, although definitive evidence of a causal relationship awaits a true experiment, we believe the current findings strongly merit a causal interpretation.

GENERALIZABILITY

Before we discuss the contributions and implications of these findings, a few cautions regarding their generalizability are in order. The sample used here, although relatively representative of the general population of ADD children, does have some potential limitations. The children in this sample were perceived by their parents to have relatively severe attention deficit symptoms. Also, the families were relatively wealthy, with 63% earning an annual household income of $50,000 or more. And the majority of this sample lived in relatively green residential areas. Thus, the findings may not generalize to children with milder symptoms, who have families with lower incomes, or who live in relatively barren residential surroundings.

In addition, the location and timing of the data collection may pose some limitations regarding generalizability. The data were collected from a limited geographic region, the midwestern United States. Thus, the question arises, do these findings apply to children living in regions without green trees and grass? For example, children in desert settings may not receive the same benefits from contact with nearby natural outdoor settings. Furthermore, this study was conducted within a short period of time during a single season, autumn. Is the nature-attention relationship still as strong during the summer months, when children have fewer attentional demands (i.e., no schoolwork)? Is the nature-attention relationship as strong during the winter months, when there is very little green vegetation available?

CONTRIBUTIONS

This work contributes to the research on nature and attention in three ways. The work here extends Attention Restoration Theory, expands the literature concerning children and nature, and provides a potential new methodology for studying directed attention in children.

This study extends Attention Restoration Theory to a new population, providing evidence that the theory may apply to children. Whereas Attention Restoration Theory suggests that nature supports directed attention functioning in all humans, previous research has only provided evidence that the theory applies to adults (Canin, 1991; Cimprich, 1990; Hartig et al., 1991; Kuo, in press; Lohr et al., 1996; Miles et al., 1998; Tennessen & Cimprich, 1995). This study is the first to indicate that the theory applies to at least a subpopu-

lation of children, children with ADD. Thus, there is now evidence that Attention Restoration Theory applies to both adults with normal attentional functioning and children whose attentional functioning is compromised. Together, these findings provide some indication that the nature-attention relationship may apply to all children.

This study also extends the literature on the benefits of nature for children. The previous literature has provided some evidence that green spaces foster play and—of particular importance—creative play (Kirkby, 1989; Moore, 1989; Taylor et al., 1998). In addition, previous investigators have suggested that contact with nature supports children's general well-being by providing children with privacy and mental and sensory stimulation (Heseltine, 1987; Jansson, 1984; Miller, 1972; Nabhan & Trimble, 1994; Senda, 1992; Striniste & Moore, 1989). To date, however, no studies have examined the effects of contact with nature on children's attentional functioning. Trancik and Evans (1995) did speculate that, for preschoolers, the stress of the new school environment might cause attentional fatigue and that, therefore, preschoolers might benefit from opportunities to play in green settings. The findings here suggest that Trancik and Evans's ideas are worth testing.

Finally, this study provides a potential new methodology for studying directed attention in children. The consistent and statistically significant differences between different activities found here suggest that parents are able to systematically assess the aftereffects of activities on their children's attentional functioning and can estimate the magnitude of these effects on a Likert-type scale. Furthermore, it appears that most parents are able to nominate activities that have especially positive and negative effects on their child's attention. Future research should assess the reliability and concurrent validity of these measures.

IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

The findings here have a number of implications for practice and future research. For children with ADD and their parents, these findings have a clear and inexpensive implication: Children with ADD can support their attentional functioning and minimize their symptoms simply by spending time in green settings. More specifically, children with ADD might use these findings in the following ways. First, before engaging in attentionally demanding tasks such as schoolwork and homework, ADD children might maximize their attentional capacity by spending time in green settings. Second, ADD children might reduce the overall severity of their symptoms by spending time in green settings on a daily basis. According to parents in the focus group, children with ADD who engage in green activities function

better both during the activity and for some time afterward. It is worth noting that children with ADD can follow these recommendations at little or no financial cost by using public and private green areas.

The findings of this study have implications for the design of children's environments such as school yards. Given that maximal attentional functioning is necessary for optimal academic performance, one implication of these findings is that green schoolyards could play an important role in children's academic pursuits. For example, recess may be more than just a time for releasing physical energy but also an important time for restoring attention. Children with ADD, and possibly all children, may perform better throughout the school day if given breaks in a green environment. In addition, perhaps something as simple as a view out the classroom window onto a green space may be providing children with much needed rest of their directed attention.

The findings of this study also have a number of implications for future research. Future research might replicate these findings both in similar settings (children's afterschool and weekend play environments), with other populations (e.g., ADD children in the southwest United States, non-ADD children), and in other settings. For example, do children who attend schools with particularly green school yards function better attentionally throughout the day than children who attend less green schools? Does the physical setting of summer camp affect ADD children's attention deficit symptoms? Perhaps, summer camps in natural settings (e.g., camping in a state park) are more beneficial for children with ADD than indoor summer camps (e.g., indoor sports camps or arts camps). Furthermore, future research might explore which specific elements of green settings are crucial in supporting attentional functioning.

Future research might also explore the temporal characteristics of the nature-attention relationship. In this study, we examined functioning immediately after participation in green activities but did not measure the duration of the activities or the duration of the effects. Is it necessary to spend some minimum amount of time in nature-related activities to experience the restorative benefits of nature? For children with ADD, how does a 10-minute walk in the park compare to a 30-minute walk in the park in terms of restoring attentional functioning? Kuo (in press) has proposed that future research should determine the shape of the *dose response curve* for nature and attention. For example, perhaps attentional functioning increases with increasing exposure to nature only up to a point, after which the benefits level out and additional exposure to nature produces little additional benefit. Another issue that deserves investigation concerns the duration of the effects. How long do

they last? Do the effects degrade in a linear fashion or do they degrade suddenly?

This study has shown that nature may support attentional functioning in children with ADD. These finding have tremendous implications for a large number of children (more than 2 million in the United States alone) struggling day-in and day-out with attention deficit symptoms. These children and their families could potentially benefit from something as simple as spending time in green areas. In addition, these findings hold potential value for children who do not have ADD. Optimal levels of attentional functioning are essential for *all* children so that they maximize learning and achievement in school. Thus, all children's attentional functioning may benefit from something as inexpensive and direct as incorporating vegetation into places where children live, learn, and play.

NOTES

1. The acronym ADD will be used throughout this article because this research theoretically hinges on children's attention deficits. However, the information also applies to ADHD, as ADHD is a broader diagnostic term under which a child can be diagnosed as predominantly inattentive (attention deficit), or inattentive *and* hyperactive/impulsive (American Psychiatric Association, 1994).

2. It is striking that in spite of a small *n* and thus low power for analysis, girls' severity of symptoms were significantly related to several measures of residential greenness.

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