A Potential Natural Treatment for Attention-Deficit/Hyperactivity Disorder: Evidence From a National Study

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Objectives. We examined the impact of relatively "green" or natural settings on attention-deficit/hyperactivity disorder (ADHD) symptoms across diverse subpopulations of children.

Methods. Parents nationwide rated the aftereffects of 49 common after-school and weekend activities on children's symptoms. Aftereffects were compared for activities conducted in green outdoor settings versus those conducted in both built outdoor and indoor settings.

Results. In this national, nonprobability sample, green outdoor activities reduced symptoms significantly more than did activities conducted in other settings, even when activities were matched across settings. Findings were consistent across age, gender, and income groups; community types; geographic regions; and diagnoses.

Conclusions. Green outdoor settings appear to reduce ADHD symptoms in children across a wide range of individual, residential, and case characteristics. (*Am J Public Health.* 2004;94:1580–1586)

Attention-deficit/hyperactivity disorder (ADHD) is the most common neurobehavioral disorder of childhood.[1] It manifests as an unusually high and chronic level of inattention, impulsivity/hyperactivity, or both, and it may affect more than 2 million school-aged children.[2] Recent statistics indicate that, among children aged 6 to 11 years, the incidence of ADHD is approximately 7%.[3] ADHD exacts a substantial toll on afflicted individuals and often persists into adulthood. According to the Centers for Disease Control and Prevention: "if untreated, a person with ADHD will struggle with impairments in crucial areas of life, including relationships with peers and family members, and performance at school or work."[2(p1)]

Unfortunately, current ADHD treatments fall far short of ideal, offering only limited relief from symptoms and often involving serious side effects.[4–7] The Centers for Disease Control and Prevention has labeled ADHD "a serious public health problem,"[8] citing "the large estimated prevalence of the disorder; the significant impairment in the areas of school performance and socialization; the chronicity of the disorder; the limited effectiveness of current interventions to attend to all the impairments associated with ADHD; and the inability to demonstrate that intervention provides substantial benefits for long-term outcomes."[8(p1)]

In this article, we report the results of 1 in a series of studies exploring a possible new treatment for ADHD. The findings outlined here, taken in the context of previous research, suggest that common after-school and weekend activities conducted in relatively natural outdoor environments may be widely effective in reducing ADHD symptoms. If controlled experiments and clinical trials bear out this potential, such natural treatments promise to supplement current approaches to managing ADHD, with the advantages of being widely accessible, inexpensive, nonstigmatizing, and free of side effects.

NATURE AND ADHD "SYMPTOMS" IN NON-ADHD POPULATIONS

Substantial research conducted among non-ADHD populations has shown that "symptoms" of ADHD—inattention and impulsivity—are reduced after exposure to natural views and settings. Environmental psychologist Stephen Kaplan has proposed that tasks and situations that require one to deliberately direct attention or inhibit unwanted stimuli, thoughts, or impulses draw on a shared mechanism that is subject to fatigue.[9,10] After prolonged or intense use of this mechanism, fatigue sets in, and it becomes increasingly difficult to pay attention and inhibit impulses; that is, the behavior and performance of individuals without ADHD temporarily take on many of the characteristic patterns of ADHD.

Indeed, the symptoms of ADHD and "attention fatigue" so closely mirror each other that the Attention Deficit Disorders Evaluation Scale has been used as a measure of attention fatigue.[11] However, unlike ADHD, attention fatigue is proposed to be a temporary condition; when the deliberate attention mechanism has an opportunity to rest, fatigue dissipates and behavior and performance improve. According to Kaplan, natural environments assist in recovery from attention fatigue, in part because they engage the mind effortlessly,[12–15] providing a respite from having to deliberately direct attention.[9,10] Thus, the sense of rejuvenation commonly experienced after spending time in natural settings may in part reflect a systematic restorative effect on directed attention.

Studies involving a variety of measures, treatments, populations, and research designs have produced evidence of enhanced attention after exposure to natural views and settings. "Nature" experienced in a wide variety of forms—including wilderness backpacking, gardening, viewing slides of nature, restoring prairie ecosystems, and simply having trees and grass outside one's apartment building—has been linked to superior attention, effectiveness, and effectiveness-related outcomes.[11,16–21] The use of experimental designs and statistical tests for mediation in some studies has helped address questions of cause and effect, and the persistence of positive findings across diverse research designs suggests that the effect of nature on inattention is robust.

In addition, there is evidence to suggest that nature can be helpful in addressing the impulsivity/hyperactivity axis of ADHD.[11,21,22] Notably, 1 study revealed direct evidence of superior performance on objective tests of impulse control in a sample of urban public housing children randomly assigned to architecturally identical apartment buildings with relatively green views versus relatively barren views.[21]

NATURE AND ADHD

The finding that exposure to nature reduces "symptoms" among individuals without ADHD raises the possibility that nature might similarly affect individuals with ADHD. Relative to individuals without ADHD, we might expect individuals with ADHD to be equally, if not more, vulnerable to attention fatigue. If so, persons with ADHD might benefit from attention restoration as well. Moreover, there are hints in the neuroscience literature that attention fatigue and ADHD are linked to the same underlying mechanism. In non-ADHD populations, the right prefrontal cortex has been implicated in both the capacity to deliberately direct attention and the presence of attention fatigue. A number of studies have produced evidence of a right frontal–cortical locus of attention control,[23,24] and another has shown that the right prefrontal cortex is subject to fatigue after sustained demands on directed attention.[25]

Correspondingly, the right prefrontal cortex has been implicated in ADHD. The right prefrontal cortex has been found to be smaller and less active among children with ADHD than among same-aged peers,[26–29] and severity of ADHD symptoms has been shown to be proportional to degree of asymmetry between left and right prefrontal cortex regional cerebral blood flow.[30] Thus, it may be that attention fatigue and ADHD represent different problems in the same underlying mechanism.

Two studies to date have examined the impacts of exposure to nature among individuals with ADHD. Both focused on children aged 7 to 12 years who had been professionally diagnosed with ADHD. In the first study,[31] 96 parents rated a variety of leisure activities with respect to whether their child's symptoms were better than, worse than, or the same as usual after engaging in those activities. Parents also rated the general severity of their child's symptoms and provided information on the "greenness" of the child's typical play settings. Results indicated that symptoms were better than usual after activities in relatively green settings. Moreover, the aftereffects of activities taking place in green outdoor settings were better than those of activities taking place either indoors or in relatively built outdoor settings, and the greener a child's typical play settings, the less severe his or her general symptoms.

Thus, both cross-sectional and longitudinal data linked greenness of children's activity settings to milder symptoms. Furthermore, the influence of green outdoor activities could not be attributed to general effects stemming from being outdoors or to social setting, amount of physical activity, type of activity, preference for nature, or timing of medication. Nonetheless, the correlational nature of these data precluded strong conclusions regarding the causal role of nature in reducing attention deficit symptoms.

A controlled field experiment (A. Faber Taylor and F.E. Kuo, unpublished data, 2004) was conducted to address the issue of causality. In this study, children with ADHD completed guided walks, while unmedicated, in each of 3 settings differing in the extent to which natural or urban elements predominated. The 20-minute walks were counterbalanced for order and controlled for day of week, time of day, walking guide, and walking pace. Routes were chosen to involve roughly equivalent levels of noise and pedestrian density. As a means of ensuring some degree of attentional fatigue, 15 minutes of puzzle-like tasks were administered to children before each walk.

After each walk, a single evaluator, unaware of condition assignments, administered objective measures of attention. Children's performance on these measures was significantly better after walking in the greenest setting than after walking in either of the other 2 settings. Because the research design compared the same child across settings, it controlled for individual factors such as age, gender, socioeconomic status, and case characteristics (e.g., comorbidity, general severity of symptoms).

These studies, both focusing on largely urban, midwestern samples of children aged 7 to 12 years, provide the first evidence to suggest that exposure to nature reduces ADHD symptoms but leave open the question of whether such effects are widely generalizable. To explore whether these effects might hold for a wider range of ages, community sizes, and geographic regions, we conducted a national, Internet-based study: the National Activity Settings and Attention-Deficit/Hyperactivity Disorder Study.

METHODS

Sampling and Response

Recruitment. Parents and legal guardians of children with ADHD were recruited via advertisements placed in major US newspapers and via the Web site of Children and Adults with Attention-Deficit/Hyperactivity Disorder (http://www.chadd.org), the largest national, nonprofit organization in the United States serving individuals with ADHD. Information on the study was posted on the Internet from September 15 to October 31, 2000. Potential participants were invited to take part in "a national study on how different activities affect children's ADHD symptoms." Two incentives were offered: a list of recommendations for coping with ADHD based on the study's findings and the chance to win a gift certificate.

Response and final sample. In the 47 days during which the study was posted, the Web site received 1053 unique hits. Access to the questionnaire itself was restricted to individuals whose responses to screening questions met the sampling criteria, according to which respondents had to be parents or legal guardians of children aged 5 to 18 years who had been formally diagnosed with ADHD by a physician, psychologist, or psychiatrist. Approximately 30% (n=315) of visitors did not meet the sampling criteria, most frequently because the child had not been professionally diagnosed. Of the qualified visitors, 71.5% (n=528) went on to fill out at least a portion of the 20- to 30-minute survey; of these individuals, 9.6% (n=71) did not respond to the portion of the survey reported here. Five sur-

veys were unusable owing to computer error. The analyses reported here were based on 452 surveys, including 6 from the Spanish version of the questionnaire. Table 1 presents the distribution of individual, environmental, and case characteristics in the final sample.

Measurement

Assessing activity setting effects on ADHD symptoms. Parents rated the aftereffects of common after-school and weekend activities on their child's ADHD symptoms. Instructions specifically mentioned 4 symptoms selected from the official ADHD[32] diagnostic criteria to be easily observable by parents: difficulty in remaining focused on unappealing tasks, difficulty in completing tasks, difficulty in listening and following directions, and difficulty in resisting distractions. For each activity in a given physical and social context, parents were asked to indicate whether that activity generally resulted in their child's symptoms being "much worse than usual," "worse than usual," "same as usual," "better than usual," or "much better than usual" for the hour or so after the activity. In the case of activities in which the child rarely engaged, parents were instructed to select "don't know."

Parents rated each of 49 survey items representing the broad range of activities, physical settings, and social contexts children experience outside of school. Of these 49 items, many examined aftereffects of the same activity across different physical and social contexts. For example, "reading" might take place indoors, in a relatively green outdoor setting, or in a built outdoor setting; moreover, it might take place alone, in a pair, or in a group of 3 or more (for the purposes of this survey reading alone or in a pair were grouped together). The survey defined a green outdoor setting as any "mostly natural area—a park, a farm, or just a green backyard or neighborhood space." Built outdoor settings were defined as "mostly human-made—parking lots, downtown areas, or just a neighborhood space that doesn't have much greenery."

Other information. Parents provided information about their child, including the child's residential surroundings and case characteristics. As a means of assessing whether participants had salient beliefs regarding the effects of green environments on ADHD symptoms, participants were asked to nominate any activities that stood out to them as having particularly positive effects on their child's ADHD symptoms and to provide any guesses as to the reason for those effects.

TABLE 1—Individual, Residential, and Case Characteristics: National Activity Settings and Attention-Deficit/Hyperactivity Disorder Study

Characteristic	No. (%)
Gender	
Female	84 (20.69)
Male	322 (79.31)
Age, y	
5–6	38 (8.80)
7–9	162 (37.50)
10–13	174 (40.28)
14–18	58 (13.43)
Household income, $	
<10 000	9 (2.36)
10 000–24 999	34 (8.92)
25 000–49 999	112 (29.40)
50 000–74 999	106 (27.28)
≥75 000	120 (31.5)
Community type	
Large city	54 (13.88)
Suburb	155 (39.85)
Medium town[a]	62 (15.94)
Small town	56 (14.40)
Rural	62 (15.94)
Region	
Northeast	106 (29.44)
South	78 (21.67)
West	82 (22.78)
Midwest	94 (26.11)
Diagnosed with hyperactivity	
No	99 (24.38)
Yes	307 (75.62)
Case severity	
Very mild	4 (0.99)
Mild	34 (8.40)
Average	119 (29.38)
Severe	176 (43.46)
Very severe	72 (17.78)
Comorbid condition	
Conduct disorder	18 (3.98[b])
Learning disorders	131 (28.98[b])
Oppositional defiant disorder	78 (17.26[b])
None	128 (28.32[b])

[a]Defined as a town with a population between 15 000 and 100 000.
[b]Percentage of total sample (n = 452) who responded yes. Not all respondents indicated comorbidity status, and some respondents reported more than 1 comorbid condition.

Analysis

In all analyses, rated aftereffects were recoded onto a numeric scale with the following values: −20, −10, 0, 10, and 20; "same as usual" was coded 0, improved symptoms were coded positively, and worsened symptoms were coded negatively. Three series of analyses were conducted. First, to examine whether activities conducted in different physical and social settings were, on average, rated as resulting in either better symptoms or worse than usual symptoms, we conducted a series of 1-sample *t* tests comparing rated aftereffects with the "same as usual" value of 0.

Second, to compare the aftereffects of green outdoor activities with those of activities conducted in other settings, we conducted 2 series of 2 × 2 (Physical Setting × Social Context) repeated measures analyses of variance (ANOVAs). Green outdoor activities were compared with both indoor activities and built outdoor activities for the sample as a whole and for each of 28 subsamples. The analyses controlled for effects of social context and for differences between children (e.g., gender, income, diagnosis). However, because there was not complete overlap of activities across settings, these analyses did not control for differences in the types of activities taking place in each setting (e.g., television viewing occurs indoors but not in other settings).

Finally, a pair of 2 × 2 repeated measures ANOVAs addressed whether any advantages associated with green outdoor activities might owe to the activities themselves rather than the settings. These ANOVAs examined the effects of physical setting and social context on the aftereffects of matched activities (e.g., reading indoors vs reading in a green outdoor setting). There were 5 activities rated in both green outdoor and built outdoor settings and 6 activities rated in both green outdoor and indoor settings.

RESULTS

Do Green Outdoor Activities Reduce Symptoms?

One-sample *t* tests indicated that green outdoor activities significantly reduced symptoms; specifically, aftereffects of green outdoor activities were assigned ratings significantly greater than 0 whether those activities were conducted alone/in pairs ($t_{430}=16.91$, $P<.0001$) or in larger groups ($t_{408}=3.77$, $P=.0002$). By contrast, built outdoor activities were judged to reduce symptoms when conducted alone/in pairs ($t_{398}=11.65$, $P<.0001$) but not when conducted in larger groups ($t_{380}=0.82$, $P=.41$). Similarly, indoor activities significantly reduced symptoms when conducted alone/in pairs ($t_{446}=6.56$, $P<.0001$) but significantly exacerbated symptoms when conducted in larger groups ($t_{438}=-6.68$, $P<.0001$). Thus, only in green outdoor settings did activities reduce symptoms regardless of social context.

TABLE 2—Symptom Reduction Differences: Activities Conducted in "Green" Outdoor Settings Versus Other Settings

	Green Outdoors vs Built Outdoors				Green Outdoors vs Indoors			
Characteristic	F	*df*	*P*	Mean Difference	F	*df*	*P*	Mean Difference
Gender								
Female	7.7	72	≤.001	1.16	22.3	77	≤.0001	2.59
Male	19.5	294	≤.0001	1.32	128.5	302	≤.0001	3.56
Age, y								
5-6	9.6	31	≤.001	2.55	13.6	31	≤.001	3.16
7-9	4.2	130	≤.05	0.94	59.3	141	≤.0001	3.70
10-13	11.5	149	≤.001	1.31	63.7	162	≤.0001	3.36
14-18	3.5	49	.07	1.31	26.3	53	≤.0001	3.40
Income, $								
<25 000	8.1	39	≤.01	1.76	13.1	39	≤.001	3.18
25 000-49 999	3.0	99	.09	1.00	28.7	102	≤.0001	2.69
50 000-74 999	12.3	98	≤.001	1.57	69.3	102	≤.0001	4.34
≥75 000	9.6	107	≤.01	1.34	42.3	113	≤.0001	3.40
Community type								
Large city	4.1	49	≤.05	1.14	13.8	50	≤.001	3.01
Suburb	11.1	140	≤.001	1.47	53.2	144	≤.0001	3.27
Medium town	4.9	58	≤.05	1.43	26.8	60	≤.0001	3.71
Small town	4.4	48	≤.05	1.32	33.9	52	≤.0001	3.81
Rural	4.1	55	≤.05	1.26	23.6	57	≤.0001	3.45
Region								
Northeast	7.7	91	≤.01	1.49	45.0	95	≤.0001	4.07
South	5.1	70	≤.05	1.48	25.8	72	≤.0001	3.34
West	14.4	77	≤.001	1.69	32.0	79	≤.0001	3.25
Midwest	4.1	85	≤.05	1.06	37.7	91	≤.0001	3.27
Diagnosed with hyperactivity								
No	12.2	82	≤.001	1.51	50.7	91	≤.0001	3.93
Yes	15.8	279	≤.0001	1.22	101.1	283	≤.0001	3.20
Case severity								
Very mild or mild	13.1	231	≤.001	1.23	78.2	234	≤.0001	3.14
Average	11.9	99	≤.001	1.44	52.1	109	≤.0001	3.76
Severe	11.0	163	≤.001	1.40	68.1	163	≤.0001	3.53
Very severe	2.2	67	.14	0.83	12.7	70	≤.001	2.23
Comorbid condition								
None	11.6	112	≤.001	1.59	55.5	118	≤.0001	3.33
Learning disorders	5.3	119	≤.05	1.05	37.0	123	≤.0001	3.08
Oppositional defiant disorder	1.0	72	.33	0.58	36.8	73	≤.0001	3.34
Total sample	27.0	376	≤.0001	1.31	165.3	403	≤.0001	3.43

Are Green Activities Better Than Activities Conducted in Other Settings?

Table 2 provides the results of 2 × 2 repeated measures ANOVAs examining the advantage of green outdoor activities over built outdoor and indoor activities, respectively, while controlling for social context. Before we examine the main effects of physical settings on symptoms, a brief overview of the other effects tested in these analyses is in order. Consistent with parent reports and previous research, activities conducted alone or in a dyad had reliably better effects on symptoms than did group activities. There were significant interactions between social context and physical setting in the case of 2 of the analyses depicted in Table 2; simple effects tests confirmed that the main effects of physical setting held for each of the social contexts separately.

For the sample as a whole, ratings indicated that green outdoor activities reduced symptoms significantly more than did either built outdoor activities or indoor activities. The findings for specific subsamples echoed these results with remarkable consistency; in each of 56 analyses, green outdoor activities received more positive ratings than did activities taking place in other settings, and this difference was significant or marginally significant in 54 of the 56 analyses. These findings suggest that green outdoor activities are beneficial in reducing ADHD symptoms among both boys and girls; children in the 5- to 6-year, 7- to 10-year, 11- to 13-year, and 14- to 18-year age groups; and children from 4 separate household income brackets (ranging from less than $25 000 to $75 000 or more per year). The advantage for green outdoor activities was observed among children living in different regions of the United States and among children living in a range of settings, from rural to large city environments.

In addition, the advantage for green outdoor activities held among both children with

hyperactivity (i.e., those diagnosed with ADHD) and children without hyperactivity (i.e., those diagnosed with attention-deficit disorder); among children with relatively mild, average, and severe symptoms; among children without comorbid conditions; and among children with both ADHD and learning disorders. In 2 groups—children with "very severe" symptoms and children with both ADHD and oppositional defiant disorder—green outdoor activities were significantly more helpful than indoor activities but not more helpful than built outdoor activities ($P=.14$, $P<.33$).

Are Green Settings Better After Control for Activity Type?

A 2 × 2 (Physical Setting × Social Context) repeated measures ANOVA indicated that the same activities reduced symptoms significantly more when they were conducted in green settings than when they were conducted in indoor settings or in built outdoor settings ($F_{1375}=32.1$, $P<.0001$, and $F_{1386}=21.9$, $P<.0001$, respectively).

Beliefs About Nature and ADHD

Of the 339 reasons parents gave as to why an activity might reduce their child's ADHD symptoms, only 2 could be construed as referring to green outdoor settings: "fresh air" and "ability to be outside in light, open spaces." None of the responses referred directly to nature or green space.

DISCUSSION

Overall, our findings indicate that exposure to ordinary natural settings in the course of common after-school and weekend activities may be widely effective in reducing attention deficit symptoms in children. Analyses of the sample as a whole indicated that green outdoor activities resulted in reduced children's symptoms and had more positive aftereffects on symptoms than did activities conducted in other settings. Moreover, the advantage of green outdoor activities over other activities was consistent for children across a wide range of individual, residential, and case characteristics.

Some of the specific findings of this study are worth noting in that they argue against potential alternative explanations for the green advantage. Consistent with previous research, comparisons of matched activities in different physical settings suggested that the benefits of green outdoor activities cannot be wholly attributed to differences in the activities themselves (A. Faber Taylor and F.E. Kuo, unpublished data, 2004).[31] Similarly, comparisons of green outdoor activities with built outdoor activities argued against the green advantage being solely attributable to qualities shared by outdoor settings, such as freedom of movement and changing or novel patterns of stimulation (A. Faber Taylor and F.E. Kuo, unpublished data, 2004).[31] Along the same lines, the finding of a green advantage among children with attention-deficit disorder (who are not hyperactive) suggests that the salutary effects of green settings on ADHD cannot be solely attributed to the opportunity to "burn off" hyperactive impulses.

Furthermore, it is worth noting that a green advantage was found among children who lived in communities of different sizes, lived in different regions of the United States, and were at different household income levels; thus, the benefits of exposure to relatively green settings seemed to hold despite what must have been wide variation in the specific "green outdoor," "built outdoor," and "indoor" settings available to children in these different subpopulations. In addition, the finding of a green advantage among rural children suggests that the benefits of green spaces cannot be solely a function of the relative novelty of such spaces in the larger context of urban surroundings. Finally, the advantages of green outdoor activities over other activities did not appear to be an artifact of parents' folk theories regarding the value of such activities (A. Faber Taylor and F.E. Kuo, unpublished data, 2004).[31]

A number of avenues for future research seem worth pursuing to address the limitations of the current study. One limitation of our study was the possibility of systematic error in parents' perceptions of different settings, leading to an illusion that children's symptoms are better after exposure to some settings than to others.

Another limitation is that, although we found setting differences even when comparing the same activity across different settings, the same activity may take on slightly—but systematically—different characteristics when conducted in different settings, and the differences attributed here to different settings may actually reflect differences in activity characteristics. If so, we would expect the green advantage to disappear when tested with objective performance measures after carefully matched activities. In fact, however, the green advantage remained in tests conducted under these conditions. In our recent field experiment (A. Faber Taylor and F.E. Kuo, unpublished data, 2004), ADHD children did indeed perform reliably better on an objective test of concentration after exposure to a relatively natural urban setting than after carefully matched exposures to less natural urban settings.

Thus, it appears that the green advantage found in parents' ratings reflects a systematic phenomenon that is objectively measurable and not easily attributable to activity characteristics. Nonetheless, perhaps the highest future priority is for additional controlled experiments involving the use of objective performance measures to further verify and quantify the impacts of natural settings on ADHD. Dose–response parametric variations will reveal the extent to which green activities make a difference, for how long, and under what conditions.

Future research also would be useful to confirm and extend the apparent generality of the current findings. At present, it is unclear whether the few marginally significant and nonsignificant differences observed in this study reflect systematic or random variation; for example, do children with both oppositional defiant disorder and ADHD really benefit no more from green outdoor settings than from built outdoor settings?

Along the same lines, it is not certain whether the benefits of nature extend to subpopulations underrepresented in this study, such as children from households with annual incomes of less than $10 000, children with relatively mild symptoms (as judged by their parents), and children of different ethnic backgrounds. It should be noted that, in a previous general population study involving African American children from households with annual incomes below $10 000, children living in relatively "green" apartment buildings exhibited superior attention and impulse control.[21] These findings suggest that neither low household income nor African American ethnicity

preclude children from experiencing the restorative effects of nature. Moreover, the fact that similar effects have been found among both children from the general population[11,21] and children with relatively severe ADHD symptoms provides reason to hope that the benefits of nature will extend to ADHD children with relatively mild symptoms.

Another fruitful avenue for future studies may be to extend current theory and research on attention fatigue and restoration to investigation of ADHD. Is the distinction between deliberately directed and involuntary attention[9] helpful in conceptualizing ADHD? Does ADHD confer any additional vulnerability to attention fatigue? Do environmental factors that appear to induce attention fatigue in the general population—noise, crowding, and need for vigilance[33–37]—exacerbate ADHD symptoms? The consistent findings of poorer ratings for activities conducted in larger as opposed to smaller groups are in accord with this expectation (A. Faber Taylor and F.E. Kuo, unpublished data, 2004).[31]

This line of research has exciting implications for the management of ADHD. If clinical trials and additional research confirm the value of exposure to nature for ameliorating ADHD, daily doses of "green time" might supplement medications and behavioral approaches to ADHD. These "doses" might take a variety of forms: choosing a greener route for the walk to school, doing class work or homework at a window with a relatively green view, or playing in a green yard or ball field at recess and after school.

While medications are effective for most children with ADHD, they are ineffective for some, and other children cannot tolerate them. In the case of children for whom medication is tolerable and effective, exposure to green settings as part of their daily routine might augment the medication's effects, offering more complete relief of symptoms and helping children function more effectively both at school and at home. In addition, a green dose or series of green doses might conceivably reduce the need for medication by 1 dose per day, allowing growing children to recover their appetites in time for dinner and get a good night's sleep. Finally, among those children for whom medication is not an option, a regular regime of green views and green time outdoors might offer the only relief from symptoms available. ▪

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Contributors

F.E. Kuo conceived the study, cosupervised the analysis, and wrote the article. A. Faber Taylor cosupervised the analysis, assisted with design of measures and data collection, and reviewed drafts of the article. Both authors helped to conceptualize ideas and interpret findings.

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No protocol approval was needed for this study.

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