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Unlocking the Green Dose: Nature's Cure for Enhancing Focus in Children and Adolescents with Attention-Deficit Hyperactivity Disorder (ADHD)

[1] **Niharika Gupta,** *M.A, Clinical Psychology, Amity Institute of Psychology and Allied Sciences, Amity University, Sector-125, Noida, Uttar Pradesh*
niharikagupta679@gmail.com
[2] **Dr. Babita Prusty**, *Professor, Amity Institute of Psychology and Allied Sciences, Amity University, Sector-125, Noida, Uttar Pradesh*
bpurusty@amity.edu

Abstract: Attention–deficit hyperactivity disorder (ADHD) is a highly prevalent neurodevelopmental disorder with behavioural and cognitive symptoms like impulsive and hyperactive behaviours, as well as difficulties with memory, focus and sustained directed attention. Along with prevalent pharmacological and therapeutic treatments, a novel, alternative mode of treatment has emerged, known as nature or "green" therapy. Based on Kaplan's Attention Restoration Theory, this approach suggests that exposure to natural green environments can help alleviate ADHD symptoms, such as improving cognitive functions (especially, attention and concentration). This quasi-experimental study investigated the impact of a short nature-based video on attention of 51 children and adolescents. Participants, after viewing the 8-minute video, showed significant improvements in their scores on Digit Span Tests (Forward and Backward), and reported the video to be relaxing and revitalizing. These findings support the existing research, implying the importance of "green doses" as a source of cognitive refurbishment for those living with attentional deficits.

Keywords: *Adolescents, Attention, Children, Green Therapy, Nature, Virtual Exposure*

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a widely recognized neurodevelopmental disorder affecting the daily lives of millions of children and adolescents worldwide. According to *Diagnostic and Statistical Manual of Mental Disorders*, (DSM-5; American Psychiatric Association [APA], 2013), ADHD is characterized by impairing levels of inattention, disorganization, and/or hyperactivity-impulsivity that disrupts developmental progress and day-to-day functioning in terms of academic success, social interactions, and emotional health (Faber Taylor & Kuo, 2009). Three primary markers of ADHD are – *inattention*, exhibited behaviourally, such as wandering off tasks, absence of persistence, trouble sustaining focus and being disorganised; *hyperactivity*, displayed via unwarranted excessive motor activity, fidgeting, tapping, talking; and *impulsivity*, demonstrated via hasty actions (potentially risky for self or others) occurring without forethought, desire for immediate gratification, social invasiveness (like,

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interrupting others excessively), and making important decisions without contemplating the aftermaths (APA, 2013). The disorder is diagnosed through a comprehensive assessment, clinical interviews with parents/caregiver, reports from teachers, and structured assessments like Conners' Parent Rating Scale, Connors's Teacher Rating Scale, and Vanderbilt Assessment Scale.

Often beginning in childhood (before 12 years of age), ADHD can persist well into adolescence and adulthood, with studies showing, the inattention symptoms persevere into adulthood (Kuo & Faber Taylor, 2004; Thal, 2014). Furthermore, adults show increased comorbidities between ADHD and mood and anxiety disorders, alongside reduced job productivity and increased turnover (Thal, 2014). A study by Ayano et al. (2023), reported a global prevalence rate of 8%. In India, the ADHD prevalence rates in children range between 1.6% to 14% (Gore & Morgan, 2025; Suthar et al., 2018).

Though, conventional treatments, including medication and behavioural interventions, remain the most common strategies for managing ADHD, medication is not recommended for children below the age of 6 due to potential side effects, high costs, and inconsistent accessibility, leading to an increased interest in alternative, more holistic approaches (Burt, 2022; Gore & Morgan, 2025; Kuo & Faber Taylor, 2004). One such emerging alternative is the correlation between nature exposure and enhanced cognitive functioning (Di Carmine & Berto, 2020; Kaplan, 1995; Wells, 2000;). "Green Therapy" – a subset of this field specifically concentrating on ADHD symptoms before and after exposure to nature – shows huge potential for treating people with ADHD at a low cost, especially with extensive accessibility to green spaces, with some studies indicating it to be as effective as medications (Faber Taylor & Kuo, 2009; Faber Taylor et al., 2001; Thal, 2014).

The theory that is the keystone of "Green Therapy" is called the *Attention Restoration Theory*, or ART, given by Rachel and Stephen Kaplan in 1989 (Berman et al., 2008; Kaplan, 1995; Kaplan, 2001; Thal, 2014). Individuals, according to William James, display two types of attention: *voluntary* (i.e., directed) and *involuntary* attention (James, 1892; Kaplan & Berman, 2010). In *involuntary* attention, an individual does not need efforts to pay attention to a stimuli as the stimuli is fundamentally stimulating or enticing. On the contrary, *voluntary* or *directed* attention, requires a person to apply efforts and consciously focus on a stimuli which might not be particularly appealing for the individual (Berto et al., 2010; James, 1892; Kaplan & Berman, 2010; Thal, 2014). Kaplan (1995, p. 169) states, directed attention is "employed when something did not of itself attract attention, but when it was important to attend nonetheless." This clarifies why people with ADHD are able to uphold attention on tasks they find fascinating (utilizing involuntary attention), but are unable to do so when given unexciting tasks (utilizing directed attention) (Faber Taylor & Kuo, 2009). Moreover, since directed attention requires conscious efforts, it is prone to get fatigued or become progressively effortful and unproductive. This explains why performance of individuals with ADHD usually worsens as the day progresses (Faber Taylor & Kuo, 2009).

ART, however, states that *natural environments* have the innate ability to *restore* our internal *directed attention* mechanisms, helping them to recuperate from stress and consequently improve functioning (Berto et al., 2010; Thal, 2014). It discusses how various environments impact attention differently, i.e., environments that utilize more deliberate attention are more fatiguing whereas those that draw on involuntary attention are revitalizing and restorative (Berto et al., 2010;

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Faber Taylor & Kuo, 2009; Kaplan, 1995). These restorative environments should have four essential elements: *being away* (experiencing a variation in scenery), *fascination* (how certain stimuli like sunsets/sounds of birds can effortlessly catch attention), *extent* (a sense of connection through spatial design [small parks feeling expansive] or chronologically [monuments]), and *compatibility* (people feeling affiliated with their surroundings through activities like trekking, hunting etc.) (Kaplan, 1995; Thal, 2014).

1.1 *Hypothesis*

In order to fill the gaps, i.e., limited research on utilization of virtual methods of nature exposure and testing ART on individuals with ADHD specifically in countries like India, the current study aimed to examine the effects of exposure to nature through virtual contact (i.e., through a short nature–walk video intervention) on attention/focus in children and adolescents diagnosed with ADHD. The purpose of the study was to explore whether the participants' performance on attention–based tests will change after viewing the video of a nature walk containing visual and auditory forms of nature. Based on the available literature, the study hypotheses that participants' performance on attention–based tests will improve significantly after viewing the nature video.

2. Literature Review

2.1 *Evidence for ART application*

Several researches have investigated whether or not the assumptions of ART, i.e., contact with natural (or green) environments help restore fatigued directed attention, and help people with or without ADHD perform better at cognitive tasks that require voluntary attention (Thal, 2014; Collado & Staats, 2016). Experimental studies by Amicone et al. (2018), Bernardo et al. (2021), Berto et a. (2015), Greenwood and Gatersleben (2016), Li and Sullivan (2016), and Mason et al. (2022) indicated that neurotypical children and adolescents, when exposed to nature via methods like, nature walks, play-time in green areas, built-in greenspaces, and so forth, for varied durations, showed improved performance at cognitive (specifically, attention) tasks as compared to those who were either exposed to a different setting, like, urban areas, closed classrooms, and so on (Nguyen & Walter, 2024).

Some of the most popular studies that assess the effects of ART on children and adolescents with ADHD include those conducted by Faber Taylor and Kuo. In 2004, they collected data through nationwide surveys filled out by parents of children with ADHD symptoms, and found that outdoor activities in greenspaces significantly reduced symptoms compared to build outdoor and indoor areas (Kuo & Faber Taylor, 2004). In 2009, these researchers extended upon this by performing controlled trials in the form of 20 minute walks with each of the 17 children to all three environments (a city park, residential area and downtown area). The results indicated that performance on attention tasks improved after the walks in the park (Faber Taylor & Kuo, 2009). Similar to their 2004 study, this team conducted another one in 2011, and collected data from parents of 421 children with ADHD symptoms, which revealed that children who often play in green settings had milder ADHD symptoms as compared to those who played indoors or in built outdoor areas (Faber Taylor & Kuo, 2011). Based on the findings from all their research, the team suggest that "doses of nature may very well function as a safe, economical, and extensively

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accessible new device in the tool kit for managing symptoms of ADHD" (Faber Taylor & Kuo, 2009).

Other important studies in this area includes those of – Yang et al. (2019), who conducted a study on 59,754 children (with 2566 having ADHD) in China, and found out, through satellite images, that those who studied in schools surrounded by greenery had lower ADHD symptoms compared to those whose schools/kindergartens didn't have greenery around. Furthermore, research conducted in New Zealand by Donovan and colleagues (2019), with 49,956 children found that those who lived in rural areas with more greenery around had reduced risks of having ADHD symptoms. Likewise, Van den Berg and Van den Berg (2010) conducted a study in Netherlands, with 12 children (in 2 groups of 6 each) who stayed at care farms for children with ADHD, and visited either woods or towns. After being systematically observed, questioned and tested on cognitive tasks, the researchers found that both groups had better concentration on tasks, more positive feelings and reduced symptomatic behaviours, after visiting the woods.

2.2 *Evidence for virtual nature*

Very limited studies exist which use virtual means of exposing participants with ADHD to nature (like videos, images and virtual-reality (VR) systems) to see whether they improve cognitive functioning. Recently, a study done by Singh et al. (2024) in Poland, found that the children (with and without ADHD) who had lifelong as well as current virtual exposure to gardens, trees, and water bodies showed significant improvement in attention as compared to those who did not have such exposure.

Several studies, without an ADHD population, were found that indicate the same. Bourrier et al. (2018) conducted a study in which participants completed Digit Span Backward (DSB) and Raven Matrices tests before and after watching either a nature or an urban video or no video at all. Findings indicated that performance on DSB significantly improved after exposure to nature video as compared to the other two conditions, with performance on Raven matrices task staying unchanged. Further, Abbot et al. (2016) conducted a study with undergraduate students and found that in the natural sounds condition participants performed better in DSB as compared to other sound conditions, i.e., low natural, low and high anthropogenic and no sound. Moreover, Lin and colleagues (2014) conducted a research in which they placed 138 participants in four groups and exposed them to different images of: streets (i.e., without greenery, with flashes of greenery and minimal awareness, with greenery, and with greenery and voluntary attention). They found that participants' performance on attentional tests improved when they saw images of streetscapes with flashes of trees, and improved even more when they voluntarily paid attention to images of streets with foliage. Likewise, Berman et al. (2008) conducted a study with 12 university students who performed better on attention tests, such as DSB and attention network test (ANT), after watching nature images (like, foliage of Nova Scotia) as compared to when they saw pictures of urban settings (like, downtown in Detroit and Chicago). Finally, Berto (2005) did a study in which participants, over three different experiments, viewed images of either restorative natural environments, nonrestorative urban settings, and geometrical patterns after being attentionally fatigued. The findings were consistent with other research, i.e., there was significant improvement in Sustained Attention to Response Test (SART) after watching images of natural environments.

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3. Method

3.1 *Participants Characteristics and Recruitment*

This study utilized a purposive and convenience sampling method to recruits participants from various schools and child development and learning centres. Emails were sent and phone call were made to many organizations and schools to get approval for conduction of the research. Messages were circulated on WhatsApp groups as well to get individuals to enter the study. Finally, consenting organizations and parents were connected with, to administer the intervention and collect data.

The *inclusion criteria* was set as participants aged between 8–18 years, labelled as children (8-12 years) and adolescents (13-18 years) and diagnosed with ADHD by a licensed mental health practitioner (i.e., a clinical psychologist or psychiatrist). Participants that were taking medications for the same were *excluded* from the study to ensure results obtained were due to the intervention and not any interaction effects between the intervention and medicines. Total sixty individuals agreed to participate in the study. Of those, three were excluded from the study as they were on medication for their ADHD symptoms, four fell beyond the age range being studied, and two were highly noncompliant during the session due to which they scored a zero in all trials of the Digit Span Tests. The final sample included 51 participants (37 males and 14 females) with a mean age of 12.65 years.

3.2 *Materials or Intervention*

A nature–based video that fulfilled the requirements of the study was carefully selected from YouTube, which consisted of a nature walk recorded in a Canadian forest (4K Relaxation Channel, 2020). It included visuals of foliage, trees and a waterbody; alongside auditory stimuli like, sounds of birds chirping, flowing water and rustling leaves. The video was screen recorded and then edited down from a length of 3 hours to 15 minutes and subsequently to 7 minutes and 58 seconds, based on responses from participants as well as observations by the researcher of attentive body language displayed by the participants.

3.3 *Measures*

Digit Span Tests (DST) are extensively used, standardised means of evaluating concentration. These tests are helpful for detecting any discrepancies in attention, as moving things in and out of one's attentional focus requires directed attentional abilities and executive functioning (Berman et al., 2008; Faber Taylor & Kuo, 2009; Thal, 2014). Thus, these tests are highly recommended by researchers for diagnosing ADHD (Faber Taylor & Kuo, 2009). The Digit Span Forwards requires listening and repeating aloud a sequence of numbers, three to nine digits long (e.g., 3-8-6) in the same order. Similarly, in Digit Span Backwards, participants repeat a string of numbers, two to eight digits long (e.g., 5-7-4) in the reverse order (e.g., 4-7-5). If a participant gives a correct response in Trial I, a new longer sequence is presented from the same Trial; but after every incorrect response, they try another sequence of the same length from Trial II. If both trials are attempted incorrectly, the test is discontinued. The scores in each test is the highest number of digits repeated accurately, and the total score on DST is the combined score of both forwards and backwards tests (Faber Taylor & Kuo, 2009; Malin, 1969).

3.4 *Design, Procedure and Analysis*

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This study employed a quasi–experimental design within a single group, also called "one–group pretest–post-test design." In this type of design, there is no control group and effects of an intervention are studied within the same group before and after the exposure to the intervention.

After entering the study, all the participants were called one by one to a quiet, well–lit, distraction free room at the respective institutions where the study was conducted. Informed consent forms were signed and diagnostic information was given beforehand by the teachers or caregivers of all participants. After building a quick rapport with the participants, their basic demographic information (such as, name, age, gender and education/grade) was collected. To ensure the confidentiality of all the participants, their names were coded such that only the initial of their first name and first three letters of their last name were recorded. Following this, the pre–intervention Digit Span testing (both, forwards and backwards) was conducted to establish the participants' baseline attention levels and to ensure some degree of attentional fatigue. Next, each participant was shown the nature walk video on a laptop. After the video ended, they were asked simple questions about their views and experience of watching the video. Finally, the post–intervention Digit Span testing (both, forwards and backwards) was performed, after which each participant was thanked and escorted. The scores of both pre and post-tests, as well as the demographic information were recorded simultaneously in a diary, later input into an Excel sheet.

Data analyses were conducted using SPSS version 20 (IBM, 2011) and graphs were generated using Microsoft Excel. To test the hypothesis, a paired sample t–test was performed to explore whether there was a significant difference between pre–intervention and post–intervention performances of participants on both Digit Span Tests. Graphical representations to visualise the difference in performance before and after the intervention were also created for better understanding and to check for outliers.

4. Results

Of 51 participants, 49 participants had a better performance on Digit Span tests after viewing the nature video. As shown in Table 1, the mean post–test scores (M=10.86, SD=2.74) of participants were more than their mean pre–test scores (M=8.75, SD=2.44). Figure 1 shows the difference in pre (dark green line) and post (light green line) intervention performances of all participants in the sample using a line graph. It can be seen that performance of DST enhanced post exposure to the nature video. Moreover, on the paired samples test (see Table 2), a significant improvement (t(50)=13.234, p=.000) in the post–intervention scores of participants was seen as compared to their scores before the video was shown (i.e., pre–intervention scores).

Table 1. *Comparison of Pre & Post Means of Participants*

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	**Total Score (Post)**	10.86	51	2.742	.384
	Total Score (Pre)	8.75	51	2.440	.342

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Figure 1. *Line Graph Scores of Every Participants on Digit Span Tests*

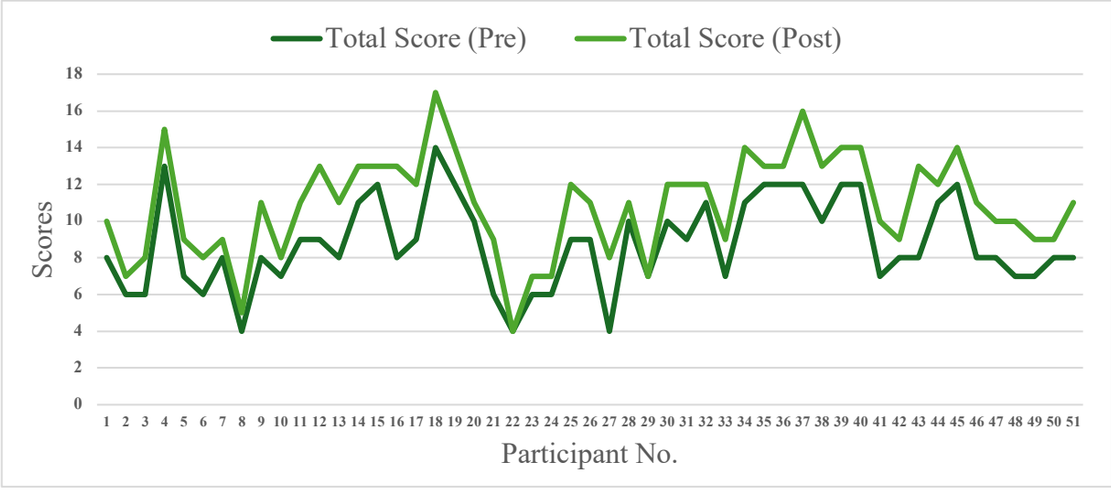

Table 2. *Paired Sample T-test Examining the Difference between Scores of Participants Pre and Post Intervention*

		Paired Differences							t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		99% Confidence Interval of the Difference				
					Lower	Upper	Lower	Upper			
Pair 1	Total Score (Post) –Total Score (Pre)	2.118	1.143	.160	1.796	2.439	1.689	2.546	13.234	50	.000

5. Discussion

The purpose of this study was to examine whether exposure to a virtual nature walk would improve attention of children and adolescents diagnosed with ADHD. The results of analysis of the collected data suggested that there was a significant improvement in participants' performance on Digit Span Tests after watching the nature–based video, as compared to their performance before watching it. Moreover, upon being asked about their views and experiences of the video, most of the participants reported that they found the video to be very calming and revitalizing. Observations by the researcher also supported available literature on the topic, as the participants looked completely immersed in the video, sitting through it quietly and calmly returning to their classrooms. These findings are consistent with earlier studies conducted to test Kaplan's Attention Restoration Theory (Kaplan, 1995) and support the hypothesised potential restorative benefits linked with exposure to natural or green settings (Berman et al., 2008; Berto, 2005; Duvall & Sullivan, 2016; Faber Taylor & Kuo, 2009; Thal, 2014).

In accordance with previous research findings, this study also indicates that spending time in nature/greenery can help alleviate ADHD symptoms in children and adolescents, meaning, the "green doses" of nature might be effective for both short–term and long–term symptom reduction such cases (Faber Taylor et al., 2001). This study also adds to the literature suggesting that regular access to greenspaces may be as effective as medications in lessening ADHD symptoms, and how it can improve task performance by reducing attentional fatigue, which ADHD is more susceptible to (Faber Taylor & Kuo, 2009, 2011). Additionally, while several cognitive researches on benefits of nature exposure uses virtual methods, limited evidence exists for similar benefits for ADHD

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populations. This study demonstrates that watching nature videos can benefit ADHD cognition as much as real nature exposure.

This study examines nature's effect on Indian individuals, an area not well-researched, providing valuable insights for schools, learning centres, and parents in India on natural remedies for ADHD in children and adolescents. Schools can create green-view classrooms and organize garden activities, while parents can take children on nature trips like trekking, camping, and birdwatching (Faber Taylor & Kuo, 2009; Kaplan, 2001; Van den Berg and Van den Berg, 2010). Teachers and caregivers can use built-in indoor and outdoor greenspaces regularly to help students recover from attentional fatigue and learning difficulties, and succeed in task performances. This will boost confidence, reduce stress, and strengthen relationships for children and adolescents with ADHD (Damasceno et al., 2022).

6. Limitations and Future Recommendations

While this study offers valuable insights, it has several limitations, which future researches might need to work on. *Firstly*, though many previous studies had even smaller samples (Faber Taylor & Kuo, 2009; Thal, 2014), the small sample size from a single city (Delhi) limits generalization, especially in a large country like India. *Secondly*, whilst results align with previous research with nature exposure through a video being effective, merely utilizing a virtual method (due to safety reasons and few restrictions) does not fully capture the connection with “actual” nature. *Thirdly*, the study did not examine how different economic backgrounds or gender might impact performance (Thal, 2014). *Finally*, some participants had a comorbid disorder (like, specific learning disorder (SLD), autism spectrum disorder (ASD), social anxiety) which were not studied, so it is unclear whether a comorbidity influenced attention–based task performance.

Future research should address these limitations by including larger, more diverse samples, exploring more variables using varied time–durations for delivering nature, and using various methods (e.g., images). More research work in India can investigate the advantages that the local nature can provide to individuals with ADHD, and whether nature can improve other symptoms like hyperactivity and impulsivity. Lastly, it will be interesting to explore mother nature’s effects on individuals with other neurodevelopmental disorders, such as SLD, ASD, or intellectual disabilities (ID).

7. Conclusion

ADHD is a highly prevalent neurodevelopmental disorder that is affecting the lives of many individuals, globally. Though several treatments exist for it, many people don’t have access to them due to factors, like high costs, long durations of treatments, unavailability of mental health professionals, and many more. Alternative treatments, like “green therapy,” propose similar benefits of healing symptoms of ADHD as do other treatment modalities. Along these lines, this study focused on assessing the impact of short virtual exposure to nature on attention among children and adolescents with ADHD. The findings provide further evidence of the restorative properties that nature holds in enhancing attention/focus in these individuals. Even though more research is required to understand the nitty-gritties of this process, the existing evidence indicates

that incorporating small “doses” of nature in life can help people in more ways than one can imagine.

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