EFFECTS OF MODIFIED NATURE STIMULI ON CHILDREN WITH ADHD

by

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Abstract

Attention restoration theory (ART) suggests that natural environments demand fewer cognitive resources, allowing for a fast recovery from attention fatigue (Kaplan,1995). Modified nature therapy is often used on medical patients experiencing disorders such as anxiety, depression, and dementia. Previous studies have proven authentic and modified nature to positively affect attention, mood, cognition, and working memory intervals. Nature stimuli can reduce psychological symptoms that are associated with neurodevelopmental disorders. Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that causes age-inappropriate attention, hyperactivity, and impulsivity levels. Studies have suggested that an individual's access to green spaces affects the likelihood of developing ADHD symptoms as a child (Yang et., 2019). Urban communities often lack green amenities such as parks, gardens, and fields, often burdened with a high volume of traffic pollution and noise. This thesis examines and analyses previous studies on the effects of modified nature on cognition, attention, and working memory. The proposed research explores the impact of incorporating modified nature stimuli into urban elementary classrooms through imagery, videos, and sound. Different forms of modified nature stimuli are hypothesized to improve classroom attention, cognition, and working memory, ultimately treating common ADHD symptoms found in urban children. The third-grade participants will be assessed on their ADHD symptoms through a Vanderbilt ADHD Parent Rating Scale (VAPERS), followed by a Stroop color test to measure processing speed, and a person's selective attention aptitude and skills, and a Digit span test to assess working memory, visuospatial processing, and attention; patients will be evaluated before and after the 15-week trial period.

Urban communities

Living in urban communities inflicts increasing demands on our cognitive resources; studies have found an association between loud noise and negative cognitive development in children (Jafari et al., 2019). In urban environments, noise pollution was associated with significantly greater stress and disturbance, leading to attention problems and chronic learning disabilities (Abbott et al., 2016). Noise has different adverse effects on mental and physical health, including cognitive impairment, cardiovascular disorders, and sleep disturbance (Jafari et al., 2019). Observations have implicated noises that impact the central nervous system, causing emotional distress, cognitive and memory defects (Jafari et al., 2019). The mental workload and attention of 54 subjects were evaluated during exposure levels to background noise (45, 75, 85, and 95 decibels A (dBA); Jafari et al., 2019). Examples of 45dBA include talking or a radio in the background, 75dBA refers to the sound of a vacuum cleaner, and 85-95 dBA includes heavy traffic or sounds from a lawnmower. The experiment began with a 10-minute relaxing phase, followed by controlled background noise (45dBA). Students were given an Integrated Visual and Auditory Continuous Performance Test (IVA); IVA is used to evaluate auditory and visual attention. After the test, the subjects were given 30 minutes to rest before exposing them to the noise (75, 85, 95 dBA). When exposed to noise at a decibel level of 95, the findings indicated that mental strain and auditory and visual attention are dramatically reduced (Jafari et al., 2019). Results further support the theory that noise impacts cognitive performance, brain signal

s and affects the communication between the nervous system and the brain. In addition, noise pressure level also plays an essential factor in the impairment of cognitive function.

High levels of traffic-related air pollution (TRAP) are caused by car and truck traffic. Impairments to children's cognitive, behavioral, and psychomotor development have been linked to TRAP exposure (De Prado Bert et al., 2018). A study examined brain growth and cognitive effects associated with air pollution exposure in 40 Mexico City and Polotitlan city children. De Prado Bert et al. (2018) study found children exposed to ambient air pollution in Mexico City had Magnetic Resonance Imaging (MRI) prefrontal lesions and cognitive abnormalities. Researchers compared MRI prefrontal lesions from Polotitlan children, used as control, given the city's low number in air pollution. Data indicated that those in Mexico City performed worse on various cognitive tests than children in less polluted cities such as Polotitlán (De Prado Bert et al., 2018). These findings suggest that exposure to air pollution disrupts the development of the brain, resulting in cognitive deficiencies throughout adolescence.

Green spaces benefit low-income communities; green amenities such as gardens and parks allow plants to absorb TRAP and release oxygen through photosynthesis. Urban areas are home to several low-income communities that are more likely to live in regions exposed to higher levels of air pollution; this finding is partially a result of a lack of green amenities (Grinspan et al., 2020). Due to increasing urbanization and spatial planning of densification, low-income families face the prospect of living in areas with a scarcity of green resources (Mass et al., 2006). In other words, low-income families have fewer grass, trees, and field opportunities.

ADHD

Attention-Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent mental diseases affecting children and adults. ADHD is a neurodevelopmental disorder that starts

predominantly during childhood or early adolescence. ADHD involves age-inappropriate levels of inattention and hyperactivity-impulsivity that hampers a person's typical development or functioning (Franke et al., 2018). According to the Center for Disease Control (2016), 6 million (9.4%) children ages 2-17 have been diagnosed with ADHD. Also, comorbidities are connected to ADHD; 64% of children diagnosed with ADHD have at least one other mental, behavioral, or emotional disorder (Center for Disease Control, 2016). Individuals with ADHD experience disorders such as anxiety, depression, and autism spectrum disorder. Adolescents with ADHD perform poorly academically and are at a higher risk of social problems and family conflict than children who do not have ADHD (Taylor et al.,2001).

Two forms of treatment for ADHD exist: non-pharmacological and pharmacological. Many patients or parents of patients try the non-pharmacological route by attending cognitive therapy and behavioral therapy sessions. Another therapy option is for parents to train in behavioral management; a therapist helps parents improve skills to manage their child's behavior productively. Behavioral therapy includes direct contingency management, where children earn or lose points for exhibiting specific behaviors. Non-pharmacological treatments aid certain sociological and behavioral issues experienced by children with ADHD. However, researchers have suggested that adolescents with ADHD receive the best results when cognitive behavioral therapy is combined with pharmaceutical treatment (Cherkasova et al., 2016).

Others take the pharmacological route; the most commonly used compounds in this class include methylphenidate-based (e.g., Ritalin, Concerta, Focalin, Metadata, Daytrana) and amphetamine-based (e.g., Adderall, Dexedrine, Vyvanse) formulations. These medications have improved social and academic functioning in children with ADHD (Charach & Fernandez,

2013). However, these medications can have adverse side effects such as insomnia, edginess, reduced appetite, and altered appetite (Charach & Fernandez, 2013)

Attention Restoration Theory

Attention restoration theory (ART); Kaplan, 1995) implies that mental fatigue comes from our busy lives; this causes the loss of the ability to focus, make rational decisions, and control emotions (1995). ART claims that natural environments require fewer cognitive resources and allow one to recover attention (Ohly et., 2016). Direct attention refers to deliberately paying attention, commonly used when driving, doing tasks, and problem-solving. Involuntary attention is the opposite, as it does not require effort. The occurrence of directed attention fatigue responds to sustained and intense mental effort. Kaplan suggests that elements of the natural environment call on our involuntary attention, which is helpful for resting and fast recovery of fatigue from directed attention. According to ART, four key components characterize a restorative environment: being away, extent, soft fascination, and compatibility. Being away refers to the psychological separation of usual thoughts and concerns, such as worries about school, work, or personal problems. Extent resides in a setting with enough rich substance and coherence to be viewed as an "entirely different world" with enough to observe and think about to keep the mind fully engaged (Felsten, 2008). Fascination refers to the individual attention being captured without needing to focus or direct attention in a certain way. Lastly, compatibility is the feeling of enjoyment; it must be an environment chosen out of intrinsic motivation (Felsten, 2008).

Felesten (2008) experimented to determine the most beneficial areas to take a study break on campus. The participants included 236 college students enrolled in psychology courses.

Students completed the study online using a website that provided the environmental stimuli (work areas facing brick or white walls, work areas with nature scenery). A 7-point Likert scale was used to evaluate the critical four components of a restorative environment (being away, extent, fascination, compatibility). Felesten reported that categories with greater visual green space scored higher on the Likert scales for meeting the four components of a restorative environment (2008). The study suggested that areas with fewer buildings and greater visual green space allow individuals to obtain a greater sense of being away, extent, fascination, and compatibility.

Exposure to Authentic Nature

Greenness exposure improved working memory and attentiveness in brain regions (Yang et., 2019). A total of 59,754 school children (ages 2-17) took part in a population-based cross-sectional survey. During the past six months, parents were required to rate the frequency of 18 ADHD symptoms. The child's school exposure to greenness was calculated using two vegetation indexes taken from satellite images. Data showed that normalized difference vegetation index (NDVI) within 500 miles of a school, more greenery, was significantly associated with lower chances (odds of symptoms were 0.87 and 0.80) of ADHD symptoms (Yang et., 2019). Findings suggest a possible beneficial association between ADHD symptoms and school-based greenness. These findings are significant because many city children don't have many green spaces surrounding their homes or schools (Yang et., 2019).

Berman et al. (2008) conducted two experiments to test if walking in nature can improve attention function abilities as measured with the attention network task and digit-span task. Thirty university students were randomly assigned to take a 50-55 min walk through the park or

downtown. Researchers compared pre and post-digit-span tests, Attention network tasks, and positive and negative affect schedules (PANAS) for each condition. A digit-span test is a sequence of numbers displayed on a screen; participants are then asked to recite the number in the correct order. Data revealed that post-digit tasks and attention tasks were significantly better for participants in the nature walk condition than in the downtown walk condition; the downtown walk condition showed no improvement from pre- to post-test (Berman et al. 2008).

Studies have demonstrated that direct exposure to green settings helped adolescents with ADHD or attention deficit disorder (ADD). At the same time, non-green spaces exacerbated the adolescents' ADHD symptoms. Taylor et al. (2001) observed the effects of exposure to nature through leisure activities on children's attentional functioning. Using surveys, parents evaluated their children's attention after the leisure activities, such as playing basketball or riding a bike. Data indicated that children's attention function was significantly greater when actions were in green settings than indoor settings; attention deficit symptoms are reduced when exposed to "greener" settings (Taylor et al., 2001). The settings of intrinsic activities, activities that an individual is naturally motivated to do, following the four critical components of a restorative environment (being away, extent, fascination, and compatibility), allow for mental and attentional fatigue to be restored in children experiencing ADHD symptoms.

Community gardening is a tangible way to incorporate green experiences into urban communities. For instance, a 20-session horticultural therapy program that included gardening activities such as digging, raking, watering, and harvesting significantly improved cognitive functions among seniors with dementia (Blake & Mitchell, 2016). Another study measured changes in the essential proteins in the brain (leucine, phenylalanine, etc.) related to cognitive function through low to moderate-intensity short-term gardening activities in elderly individuals.

The gardening included six activities such as; cleaning garden pots (2 minutes), raking (3 minutes), transporting plants (5 minutes), and watering (2 minutes). Blood samples taken before and after activities reported significantly improved levels of brain nerve growth factors related to memory (Park, 2019). The implications of this study indicate that moderate gardening activities show potential benefits on cognitive functioning.

Exposure to Nature Images

Direct exposure to nature isn't the only way to acquire the benefits; studies indicate that simply viewing wildlife in the form of photographs reaps similar benefits. Researchers investigated the restorative effects on cognitive functioning of interaction in urban and natural images (Berman et al., 2008). Twelve college students viewed pictures of urban or natural areas. The picture viewing lasted 10 minutes when subjects rated how much they liked each photo on a scale of 1 to 3. After viewing, subjects completed a backward digit span test, attention network test, and PANAS. Data indicated that students who viewed forest images performed significantly better on the digit span test than students in the condition of the urban image. Individuals can gain the cognitive benefits of nature by exposure to images rather than exposure to authentic nature.

Visualization of forest scenes stimulates the brain and autonomic system (Song et al., 2018). Seventeen female university students viewed an urban landscape (control) and then a forest landscape for 90 seconds. Participants' oxyhemoglobin (oxy-Hb) concentrations in the prefrontal cortex and heart rate variance (HRV) were measured during both treatments (Song et al., 2018). Heart rate variability (HRV) measures the autonomic nervous system, allowing the determination of the body's readiness to perform. Researchers reported that viewing the forest

scene caused a reduction of oxy-Hb concentrations in the right prefrontal cortex compared to viewing urban scenes (Song et al., 2018). Focusing attention, modulation of intense emotion, and impulse control are functions of the prefrontal cortex. This study shows that viewing 2D photographs of nature resulted in deactivating visual and attentional areas of the brain. Viewing 2D pictures of nature will be beneficial for children with ADHD to restore their attention fatigue after an attention-demanding task.

Our autonomic nervous system (ANS) plays an essential role in determining our response to stress and recovery from the stressor. Brown et al. (2013) evaluated the effects of viewing nature scenes on the recovery of ANS activity after an activity stressor. Participants were shown twenty photographs of nature (trees, grass, and fields) or built scenes (buildings and urban settings) in the same order for 10 minutes through a slide show. Participants were given a forward digit span test before watching the slide show, in which they were shown a succession of six numbers for two seconds each. After each series, the participants were given 10 seconds to print them in the correct order. The cognitively demanding test was designed to elicit a stress reaction and a social evaluative threat, which are assessed throughout the testing process. Physiologic measures were also taken, including blood pressure, heart rate variability, and respiration. The researchers concluded that physiological levels increased during recovery of the natural condition compared to the built condition (Brown et al., 2013). Results suggested that exposure to nature scenes (trees, grass, and fields) before a stressor further improves the recovery rate of an autonomic nervous system post-stressor. Viewing nature can also encourage future positive and healthy stress responses and recovery patterns.

Nature sound stimuli

Studies on the effects of nature sounds have suggested lower stress, minimized self-reported distraction, maximized perceived attention restoration, and reduced pain (Van Hedger, 2019). Soundscape research perceived natural sounds as pleasant, while technological sounds have been perceived as unpleasant sound environments. A study induced psychological stress to compare the effects of different sounds on the rate of psychological recovery (Alvarsson et al., 2010). Researchers generated stress by administering a two-minute speeded mental arithmetic activity in which participants had to judge whether a displayed equation was correct or incorrect in 3 seconds. 40 university students' baseline Skin conductance level (SLC) was measured for 5 minutes, and 2 minutes of psychological stress testing was administered five times, followed by 4 minutes of relaxing with one of the sound conditions. The sounds used were nature sounds (a fountain and tweeting birds), high noise (road traffic noise), low noise (traffic noise at a lower volume), and ambient noise (recording from a quiet backyard). Data collection aligned with past research findings (Hedger, 2018); Nature sounds were rated more pleasant than the other three noises. The difference was only statistically significant between nature and high noise; SCL recovery was 37% quicker when exposed to nature sounds (Alvarsson et al., 2010). They suggested faster healing of the sympathetic nervous system when listening to nature sounds than city sounds (Alvarsson et al., 2010).

Abbott et al. (2016) investigated the influence of natural and anthropogenic sounds on restoration using a simulated park. Anthropogenic sounds are created purposefully and unintentionally, resulting in noise pollution; this study included propeller planes and motorcycles. The study examined 116 college students who identified normal vision and hearing abilities. Each subject completed a mentally fatiguing depletion task; participants then had time to recover while listening to one of the three conditions (anthropogenic, nature, or no sound).

After recovery time, participants are given a cognitive task to measure recovery. The data indicated that participants who experienced natural sounds performed better on mental tasks than subjects in anthropogenic conditions (Abbott et al., 2016). The sounds of nature are capable of relieving directional attention fatigue; however, more research must be conducted.

White noise is defined as random noise with a flat spectral density, meaning it has the same intensity and amplitude throughout the audible frequency range. White noise must consist of non-distracting and repetitive sounds on a consistent volume, such as rain sounds, birds chirping, and waterfalls. Angwin et al. (2017) investigated the impact of white noise on word learning in 69 undergraduate students. Throughout the five learning phases, subjects were shown 20 alien/name pairs individually on a computer screen. Students indicated if the pairings were correct or incorrect when displayed the second time. Participants were randomly divided into two conditions; silent condition and white noise condition. Once data was collected, researchers reported that the white noise group had a higher recall accuracy compared to the silent condition (Angwin et al., 2017). The white noise showed a positive influence on the students' attentional capacity, supporting the idea that white noise has the potential to improve lexical acquisition. Lexical acquisition is the critical stage in language development, where individuals learn sets of word forms and associate them with the word's meaning. Adding natural white noise to learning environments can help children with learning disabilities improve their vocabulary.

Videos and Video Gaming

With implications of images of nature giving the same benefits as real exposure to nature, videos have also given the same effect. Visual representation of nature is often used in hospitals, jails, and nursing homes (Jo et al., 2019). Several studies have indicated that the use of Virtual

reality (VR) is a productive method of presenting natural stimuli to participants. Igarashi et al. (2014) measured prefrontal cortex activity using near-infrared spectroscopy (NIRS) and heart rate variability (HRV) to examine the influence of 3D and 2D views of nature on the prefrontal brain and sympathetic nerve activity of 19 male college volunteers. Near-infrared spectroscopy is used to measure the oxygen saturation of the brain. Data from the NIRS showed that participants' frontal cortex activity significantly decreased for those who viewed the images of nature in 3D. Data from the HRV showed decreased sympathetic activity for participants who video the 3D video compared to the 2D. Suggesting that 3D images induced the participants' physiological relaxation to a greater extent than two-dimensional (Igarashi Et al., 2014)

Mostajeran et al. (2021) compared the cognitive effects of nature viewing through images and VR. The experiment consisted of 4 experimental conditions; 360° VR viewing of either urban or natural sceneries and slide show images of either urban or natural sceneries. Participants' cognitive function was assessed through cognition tests and surveys. Participants were tested on their math skills through a Trier Social Stress Test (TSST), where they were asked to subtract 13 from any given number. Researchers reported that participants' feelings of fatigue only increased when exposed to urban environments (VR and slide show) and decreased when exposed to the 360° of the forest. The two conditions exposing participants to forest scenes produced higher scores on the TSST than exposure to urban areas. These findings indicating that 360° videos of forest environment videos reduce negative affect and improve cognition. Results also suggest viewing videos have a more significant impact than viewing images of nature (Mostajeran et al., 2021).

Kollins et al. (2020) investigated the effects of digital therapeutic designs on the attention performance of children with ADHD. Eight to twelve-year-olds with ADHD were asked to

discontinue their ADHD treatments three days before baseline. Children were randomly assigned to two treatments; one iPad containing a digital therapeutic game targeted for ADHD treatment (AKL-T01) or a controlled preloaded game that is not targeted to treat ADHD symptoms. Participants were instructed to play the game for five sessions of twenty-five minutes a day, five days out of the week, for four weeks. Once the trial period was completed, the children were retested for attention functioning, ADHD symptoms, and cognitive impairments (Kollins et al., 2020). Data demonstrated that active intervention of the digital therapeutic game significantly improved the attention performance of ADHD patients compared to ADHD patients who received the preloaded game; patients who detoxed medication displayed significant effects between groups on ADHD symptoms. With studies showing a positive impact on the prefrontal cortex when viewing nature stimuli, video games allow users to virtually interact with environmental settings while acquiring the benefits of nature. On June 15, 2020, the FDA approved the marketing of the first game-based therapy treatment. EndeavorRx is the first video game utilized as a drug-free treatment for children with ADHD. The EndeavourRx treatment video game uses natural scenery that presents children with different challenges traveling across water and jungle.

Another study tested the outcomes of a digital treatment targeting cognitive processes that are complicit with ADHD. Subjects included 40 children without ADHD and 40 diagnosed with ADHD. After a psychiatric screening, baseline neuropsychological measures, and ADHD ratings, children were asked to complete at-home treatment of AKL-T01 (a game targeted to treat ADHD symptoms) for 28 days. Participants were given a test variable of attention (TOVA). This computerized ongoing performance test objectively assesses attention and impulsivity by presenting target and nontarget stimuli in a specified ratio. Participants are told to hit a button as

soon as they see a target but do not respond when they see a nontarget (Davis et al., 2018). The post-assessments data showed improved spatial working memory in the ADHD group and the high severity subgroup (Davis et al., 2018). Significant improvements were observed for the TOVA task for the ADHD group; however, there was no substantial change for the non-ADHD group (Davis et al., 2018). The findings suggested that digital treatment can improve working memory, attention, and inhibition in children with ADHD (Davis et al., 2018). The implications of these studies show that therapeutic environments can improve children's working memory, cognition, and emotion.

Rationale

Furthering research on the benefits of modified nature stimuli on cognition can significantly benefit children in urban communities. City environments cause mental fatigue, as it constantly requires direct attention to technological sounds and surroundings (Kaplan, 1995). Schools in urban communities are at a disadvantage due to the lack of green spaces surrounding the school. Urban schools are surrounded by high-rise buildings, polluted noises, and air from cars and trucks. The implications of the positive effects nature has on children psychologically and physiologically should encourage officials to build more playgrounds, parks, and gardens surrounding the schools. These green spaces increase the community's contact with nature, help reduce traffic-related air pollution (TRAP) and create a room for minimal noise distractions. The inclusion of gardens within urban settings allows filters of air pollutants. Phytoremediation uses plants and soil microbes to minimize the toxic effects of contaminants in the environment, delivering a natural filter and production of better air quality (Tshumamboya & Famulari, 2018). Increasing healthier air quality will reduce the adverse cognitive effects of inhaling polluted air, reducing the incidence rate of ADHD symptoms in children.

Children can benefit from natural stimuli inside the classroom as well. Presenting children with relaxing environments after an intense lesson will restore attention, provide more green around the school, and incorporate plants and nature-themed settings. One in five children with ADHD receives no school services, regardless of experiencing substantial academic and social deterioration. Lack of school services is especially apparent in children from non-English speaking and low-income families (DuPaul et al., 2018). Furthering research may also decrease the misuse of stimulants used to treat ADHD symptoms. Many teens placed on pharmaceutical treatment for ADHD are more likely to experience drug abuse (Elder, 2009). About one million American children are misdiagnosed with ADHD due to being the youngest and most juvenile in their kindergarten class (Elder, 2009). Children can get exposure to modified nature stimuli through images, videos, and sounds. The objective of the proposed study is to examine the effects of a curriculum with a modified nature stimulus on the cognitive performance of urban school children with symptoms of ADHD.

Hypotheses

Incorporating these implications into the school curriculum will benefit students, teachers, and parents.

H1: Adding natural stimuli exposure to the curriculum will improve working memory in students, increasing students' grades.

H2: Children in treatment classrooms will score higher than in the conditioned classroom on the digit span, Stroop, and word tests.

H3: The relaxing environment will improve class concentration, reducing the number of impulsive behaviors and attention fatigue tests on the digit span test.

H4: Children assigned to nature imagery stimuli will have significantly improved positive feelings towards school.

Participants

This study will focus on an elementary school located in an urban community. The participants will include four classrooms of third graders. Participants will be ordered to a 2-week detox or any pharmaceutical treatments to treat ADHD symptoms.

Conditions

Participating classrooms will be randomly assigned to 4 different treatments: (i) forest theme decorations (images of forests, jungles, and plants will be placed around the room); (ii) a 30- 60 second video of a natural environment (e.g., educational videos on the animal planet, or the natural geography), with both (i) and (ii) having an otherwise standard classroom environment. Another class will (iii) incorporate natural sounds such as rain and birds chirping (with traditional classroom decorations); (iv) a control treatment where students will continue the standard curriculum without any modifications.

Each classroom will follow the same lesson plan and have an equal number of teachers present in the classrooms. The modifications will continue for a school semester of fifteen weeks. Before and after the trial period, students will be asked to perform a post-test, digit span test, Stroop color-word test, and survey.

Assessments

Digit span test

A digit span test measures short-term verbal and working memory; clinicians frequently utilize it to quickly determine whether a patient's cognitive abilities are normal or impaired. (Woods et

al., 2011). Each participant will be presented with a series of numbers for 20 seconds and asked to state the sequence verbally and in the written form correctly.

Stroop Color Test

The Stroop color and word test (SCWT) is a neuropsychological test that evaluates a person's ability to prevent cognitive interference by blocking one sensory characteristic while simultaneously processing another (Scarpina & Tagini, 2017). Each participant will be presented with fifteen sides displaying the word of color with a different color font. Participants will be asked to correctly identify the font color within five seconds of viewing the slide.

ADHD Symptoms Assessment

Participants will also partake in a (Vanderbilt ADHD Parent Rating Scale (VAPERS), one of the most commonly used research to assess children's ADHD symptoms. The participants' parents will receive a list of 47 statements regarding their child's activities and behaviors. They will respond through 4 points Likert scale (0 is never, 1 is occasionally, 2 is often, 3 is very often). Parents will be asked to measure their child's overall academic performance (reading, mathematics, and written expression) and general classroom behavior (peer relationships, class disruption, assignment achievement, following directions, etc.). Academic performance is measured through a 5-point Likert scale; 1 and 2 are problematic, 3 being average, and 4 and 5 are above average.

The participants' scores will determine whether they are predominantly inattentive, hyperactive/impulsive, the combined subtype, oppositional-defiant disorder, conduct disorder, anxiety, or depression. The predominantly inattentive subtype is characterized by inattention problems such as procrastination and forgetfulness. That diagnosis requires a score of 6 or 9 through items one through nine; and performance problem scores of 1 and 2 on any items within

the performance section. The predominantly hyperactive/impulsive subtype (ADHD) is characterized by hyperactivity (fidgeting) and impulsiveness (making hasty decisions). Participants require 6 or 9 behaviors from items ten through eighteen and a performance problem in any items on the performance section. The combined subtype will require combined criteria on both initiative and hyperactive subtypes. The oppositional-defiant disorder is characterized by showing defiance and disobedient behavior to an authority figure; it is screened by 4 or 8 through items 19 to 26 (see Appendix A). Conduct disorder is identified as having antisocial behavior; it is filtered by 3 of fifteen behaviors from items 27 to 40. Lastly, anxiety or depression is determined by behaviors 41 through 47, with scores of 3 of 7 (see appendix A).

Statistical analysis will be done using a Statics program, JASP. A one-way analysis of variance (ANOVA) will be used to investigate the difference between modified nature stimuli conditions based on mean scores from the digit span test and Stroop color-word test. A paired samples t-test will be used to compare students' grades before and after the treatment to determine if the natural stimuli conditions affect children's academics. A one-way ANOVA will be used to assess the effect of each condition on class average scores. To test which form of nature stimuli is the most effective, I will use a one-way ANOVA to compare the difference between conditions in students' ADHD symptoms. To determine if nature imagery stimuli are more effective in creating positive feelings towards school than the sound, video, and controlled conditions. A paired samples test will be used to compare all pre and post-scores for each condition.

Limitations

Several practical limitations constrain this study. One of them is the exposure time of each stimulus; in the imagery condition, students are constantly exposed to the stimuli. Students have only been exposed to natural substitutes (the sound and video conditions) for short periods throughout the school day. These variables may affect the changes seen in ADHD symptoms between pre and post-test. It's highly recommended for future research to continue to monitor the students for 15 weeks without conditions to test lasting the effects.

It is essential to acknowledge any tutoring children are getting outside of the classroom as it can play a factor in average classroom scores. Some children with ADHD can receive services in school, such as special education services; this includes students getting pulled out of class to participate in small group instruction with a specialized teacher. Special education services also provide accommodations on testing times and work assignments for eligible students.

Parent evaluations are also a constraint due to the likelihood of response bias. Response bias is a systematic inaccuracy in prediction caused by a constant tendency to respond erroneously (untruthfully) to a questionnaire (McGrath et al., 2010). The response can be seen in self-report questionnaires and parent evaluations. Data collected from parent evaluations, teacher evaluations, and children's self-reports can cause a systematic error in the proposed study. Positive impression management can ask for a “socially desirable response” or “underreporting” (McGrath et al., 2010). This means parents, teachers, and children may respond to the questionnaires in socially acceptable ways. However, negative impression management is also where participants are “over-reporting” (McGrath et al., 2010). With the findings from previous studies, further research is crucial. It could benefit children with ADHD symptoms in urban schools, but it can also be applied to at-home situations. The findings can also reduce the usage of pharmaceutical drug treatments in adolescents, decreasing the risk of drug abuse in teens.

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Appednix

Appendix A

VANDERBILT ADHD DIAGNOSTIC PARENT RATING SCALE

Child's Name: _____ Today's Date: _____

Date of Birth: _____ Age: _____

Grade: _____

Each rating should be considered in the context of what is appropriate for the age of your child.

Frequency Code: 0 = Never 1 = Occasionally 2 = Often 3 = Very Often

1. Does not pay attention to details or makes careless mistakes, for example homework 0 1 2 3
2. Has difficulty sustaining attention to tasks or activities 0 1 2 3
3. Does not seem to listen when spoken to directly 0 1 2 3
4. Does not follow through on instructions and fails to finish schoolwork (not due to oppositional behavior or failure to understand) 0 1 2 3
5. Has difficulty organizing tasks and activities 0 1 2 3
6. Avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort 0 1 2 3
7. Loses things necessary for tasks or activities (school assignments, pencils or books) 0 1 2 3
8. Is easily distracted by extraneous stimuli 0 1 2 3
9. Is forgetful in daily activities 0 1 2 3
10. Fidgets with hands or feet or squirms in seat 0 1 2 3
11. Leaves seat when remaining seated is expected 0 1 2 3
12. Runs about or climbs excessively in situations when remaining seated is expected 0 1 2 3
13. Has difficulty playing or engaging in leisure/play activities quietly 0 1 2 3
14. Is "on the go" or often acts as if "drive by a motor" 0 1 2 3
15. Talks too much 0 1 2 3
16. Blurts out answers before questions have been completed 0 1 2 3
17. Has difficulty waiting his/her turn 0 1 2 3
18. Interrupts or intrudes on others (e.g., butts into conversations or games) 0 1 2 3
19. Argues with adults 0 1 2 3
20. Loses temper 0 1 2 3
21. Actively defies or refuses to comply with adults' requests or rules 0 1 2 3
22. Deliberately annoys people 0 1 2 3
23. Blames others for his or her mistakes or misbehaviors 0 1 2 3
24. Is touchy or easily annoyed by others 0 1 2 3

25. Is angry or resentful 0 1 2 3
26. Is spiteful and vindictive 0 1 2 3
27. Bullies, threatens, or intimidates others 0 1 2 3
28. Initiates physical fights 0 1 2 3
29. Lies to obtain goods for favors or to avoid obligations (i.e., "cons" others) 0 1 2 3
30. Is truant from school (skips school) without permission 0 1 2 3
31. Is physically cruel to people 0 1 2 3
32. Has stolen items of nontrivial value 0 1 2 3
33. Deliberately destroys others' property 0 1 2 3
34. Has used a weapon that can cause serious harm (bat, knife, brick, gun) 0 1 2 3
35. Is physically cruel to animals 0 1 2 3
36. Has deliberately set fires to cause damage 0 1 2 3
37. Has broken into someone else's home, business, or car 0 1 2 3
38. Has stayed out at night without permission 0 1 2 3
39. Has run away from home overnight 0 1 2 3
40. Has forced someone into sexual activity 0 1 2 3
41. Is fearful, anxious, or worried 0 1 2 3
42. Is afraid to try new things for fear of making mistakes 0 1 2 3
43. Feels worthless or inferior 0 1 2 3
44. Blames self for problems, feels guilty 0 1 2 3
45. Feels lonely, unwanted, or unloved: complains that "no one loves him/her" 0 1 2 3
46. Is sad, unhappy, or depressed 0 1 2 3
47. Is self-conscious or easily embarrassed 0 1 2 3

PERFORMANCE

	Problematic		Average		Above Average
1. Overall Academic Performance	1	2	3	4	5
a. Reading	1	2	3	4	5
b. Mathematics	1	2	3	4	5
c. Written Expression	1	2	3	4	5

PERFORMANCE

	Problematic		Average		Above Average
2. Overall Classroom Behavior	1	2	3	4	5
a. Relationship with peers	1	2	3	4	5
b. Following Directions/Rules	1	2	3	4	5
c. Disrupting Class	1	2	3	4	5
d. Assignment Completion	1	2	3	4	5
e. Organizational Skills	1	2	3	4	5

Scoring Instructions for the ADTRS

***Predominately inattentive subtype** requires 6 or 9 behaviors, (scores of 2 or 3 are positive) on items 1 through 9, and a performance problem (scores of 1 or 2) in any of the items on the performance section.

***Predominately hyperactive/Impulsive subtype** requires 6 or 9 behaviors (scores of 2 or 3 are positive) on items 10 through 18 and a problem (scores of 1 or 2) in any of the items on the performance section.

***The Combined Subtype** requires the above criteria on both inattention and hyperactivity/impulsivity.

***Oppositional-defiant disorder** is screened by 4 of 8 behaviors, (scores of 2 or 3 are positive) (19 through 26).

***Conduct disorder** is screened by 3 of 15 behaviors, (scores of 2 or 3 are positive) (27 through 40).

***Anxiety or depression** are screened by behaviors 41 through 47, scores of 3 of 7 are required, (scores of 2 or 3 are positive).