

USE OF TREE CANOPY IMAGES IN SCHOOL CLASSROOMS TO PROMOTE MINDFULNESS, POSITIVE BEHAVIOR, AND ENHANCE LEARNING

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www.natureintheclassroom.org

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ABSTRACT

Fifty years of research on the effects of nature images, especially trees and landscapes, has demonstrated beneficial outcomes in the well-being and healing of patients in hospitals (see references below). Tree Canopy Ceilings and privacy curtains with natural landscapes installed in over 3,500 hospitals across the US have resulted in shorter hospital stays, reduced anxiety, blood pressure and pain medication intake. This led to improved attitudes and moods of patients, family visitors, and hospital staff as measured by patient satisfaction surveys.

We have piloted the installation of Tree Canopy Ceilings in classrooms where children spend a great number of hours each week, obtaining similar benefits in children and teachers as with the hospital curtains. Educational research shows classroom views to nature or images trees boosts academic achievement, social-emotional development, and nurtures environmental stewardship.

INTRODUCTION

Research has shown that interacting with nature increases physical and mental health (Berman, Jonides, Kaplan, 2009; Ulrich, 1983, 1984; Ulrich et al,1984), and can restore psychological resources including attention and cognitive functioning (Hartig et al, 1997; Kuo, Barnes, & Jordan, 2019). Purposeful or directed attention has been described as a cognitive resource, one that can be depleted as an individual concentrates or focuses on a task or situation; attention restoration theory states that attention can be restored through nature experiences (Kaplan & Kaplan, 1989). Ulrich (1993) suggested and subsequent research shows that we respond to nature and natural views physiologically and experience reduced levels of stress after walking in or viewing nature (Li & Sullivan, 2016).

The overall benefits of outdoor activity in child development has been amply demonstrated (Louv, 2012, 2016, 2019). However, city children with little access to natural landscapes or “green outdoors” are further confined to indoor environments for substantial portions of their days at school, as well as at home. The condition of “Nature Deficit Disorder” introduced by Richard Louv (Louv, 2008; Driessnack, 2009) while not a clinical diagnosis per se, has been discussed extensively in educational circles. Bates, Bohnert, and Gerstein (2018) reported that students in urban schools showed increased and positive social interactions and less bullying after their urban school playgrounds were renovated to include increased greenspace. There is growing evidence that viewing images of nature facilitates recovery after surgery as effectively as observing a natural landscape (Brown et al, 2013; Li & Sullivan, 2016; van den Berg et al.,

2015); Research reports in the medical journals have outlined and demonstrated the beneficial effects of nature and images of nature in the rate of healing, management of pain and stress, learning disabilities, post-traumatic stress, and anger management (Berman, Jonides, & Kaplan, 2009; Ulrich, 1983, 1984). The effects on people of looking at large, beautiful nature images are comparable to the benefits of actually being in nature (van der Berg et al. 2015) and can restore psychological resources and improve cognitive functioning (Hartig et al., 1997; Kaplan & Kaplan 1989).



The Sereneview® Landscape style curtain features a large Nature scene filling the fabric part of the curtain edge-to-edge surrounding the patient with nature.

Installation of nature images in over 3,500 hospitals in the US and Canada (and other countries) has demonstrated the unique effects of built green landscapes (photographs of natural landscapes in hospital privacy curtains and ceilings). Among the benefits are faster recovery times from surgeries, shorter hospital stays, and better moods and behaviors from patients, caregivers, and families (Ulrich, 1983, 1984; Ulrich et al., 1984). Measurable physical and mental changes from exposure to images of nature can affect not only hospital patients but children as well, especially those in inner cities and urban environments with little or no access to nature. These benefits can translate into better behaviors and cognitive achievement in school children (Faber-Taylor & Kuo, 2009; Li & Sullivan, 2016; Markevych et al, 2014).



Tree canopy ceiling installation



Photographing a canopy

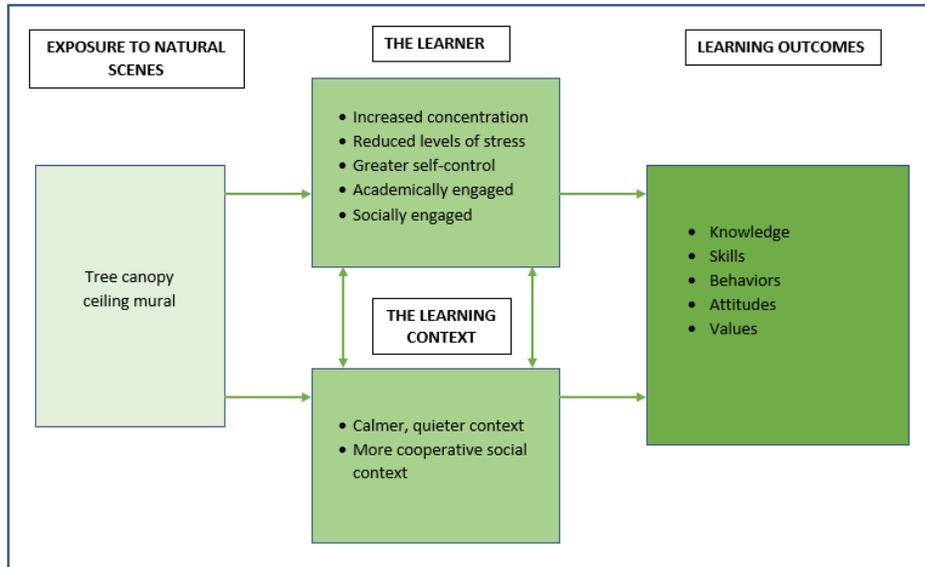
Although there has been a fair amount of research in health settings, and in classrooms with older students, much less research has been conducted in elementary school settings. Feedback from participants in schools in the pilot project for this intervention in California and Colorado inspire our research hypotheses. Teachers describe increased creativity, problem solving, focus and attention among students. Students in the pilot classrooms have expressed happiness and said that *the trees are the reason they like coming to school*. We believe that student exposure to images of nature may lead to changes in behaviors leading to less frequent disciplinary referrals, fewer referrals to the nurse's office, and fewer absences.

Urban schools serve high concentrations of low-income students, students who may have adverse home and school experiences that contribute to elevated levels of stress and reduced ability to focus on learning (single parent homes, unsafe neighborhoods, limited school resources). Compounding student home experiences, in urban schools teacher absences and turnover, bullying, and deteriorating conditions may contribute to undesirable behaviors in students that remain in the classroom. In addition, urban schools are often surrounded by concrete and brick buildings; playgrounds are often asphalt, and poorly maintained (Bates, Bohnert, & Gerstein, 2018; Markevych, et al, 2016). Research has shown that urban areas have a dearth of natural greenspace. For example, in an assessment of tree canopy in Durham, NC, one urban area of the city, had lower than average income compared to the rest of the city, and a high percentage of children in the neighborhood. The assessment of that neighborhood had just over 10% of the neighborhood covered with tree canopy (SavATree Consulting Group, 2017). Durham is not an outlier. Wolch, Byrne, and Newell (2014) reviewed literature on the distribution of urban parks, gardens, and green spaces and found that more often than not, more affluent neighborhoods had more green spaces than less affluent locations.

CONCEPTUAL FRAMEWORK:

Kaplan found that in order for students to focus on a task they must inhibit competing stimuli that distract from the task at hand (1995). The attention or mental energy required to shut out the distractions causes students to become fatigued. Attention restoration theory (ART) describes humans as ready to respond to nature and natural views and as we switch focus away from a draining task and pay attention to nature and view of nature, there is a physiological reaction, attention restoration, that leads to stress recovery (Kaplan & Kaplan, 1989; Ulrich 1993).

The conceptual framework for this project is shown below. Adapted from Kuo, Barnes, and Jordan (2019), our study will focus on physiological states of the learner including stress, self-control, and engagement while in their classrooms. The learning setting impacts learner behavior and in turn contributes to the learning context; the relationship between the learner and the learning context is reciprocal. As the learning context becomes more conducive to learning, the learner exhibits behaviors that allow for better learning. The learner and the context together contribute to learning outcomes such as increased knowledge, skill attainment, behaviors, attitudes, and values.



We propose a study that builds on the conceptual framework by investigating the impact of a specific nature image, ceiling murals of tree canopies, rather than a direct view of parks and trees. Student behaviors hypothesized to improve with the intervention, exposure to views of nature, in accordance with the findings of Hartig et al. (1997), Kuo, Barnes, and Jourdan (2019), and Li and Sullivan (2016). Ceiling murals installed in classrooms will lead to increased attention and better emotional regulation, setting students up for more meaningful learning experiences. At the same time, student absences, nurse visits and discipline referrals are expected to decrease.

FUTURE DIRECTIONS

Feedback from the pilot study, and the research results from this project can support further studies in classrooms with younger students. Head Start provides school readiness programs across the country and has expressed interest in this work. A population of students that should be studied are exceptional learners in self-contained classrooms. These students (of all grades and ages) may benefit from murals for attention restoration and stress reduction.

One area of interest the research team has is collaborating with an organization like a museum, or nature center to develop a curriculum that incorporates the tree canopy into classroom practice. Increasing students' awareness of the natural surroundings can increase their sense of nature and help develop stewardship habits. Additionally, teachers may want to investigate the use of the murals as part of a mindfulness practice, guiding students to actively engage with the view when they recognize their attention has been depleted, or their stress level is increasing.

Students in the both treatment and control classrooms in this project will conclude the school year with the tree canopy. For students who transition from a mural classroom this spring to a classroom with a mural for the next year we wonder, what are the impacts on those students? Are the effects long lasting? Does the attention restoration that they experience in the

classroom carry through in other locations (after school programs, home, church)? Would that be true especially if they have been in “tree canopy” rooms for several consecutive years? The long-term effects could provide information that schools could use when determining where they could get the highest rate of return on capital expenditures. School construction and renovation are expensive, most funding is spent on upgrading or changing the physical structure of the buildings. Landscaping and upgraded playgrounds are costly and require open space that may not be accessible in all locations. Attention restoration could be accomplished with increased exposure to nature scenes, and a ceiling mural of a tree canopy covers an entire room and can be seen from all vantage points in a room. Bringing nature into the classroom, especially a room with no windows or natural view is a method of increasing student success when schools are facing pressure to increase student achievement.

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ADDITIONAL RESOURCES

Kids and Classrooms: Why Environment Matters

<https://www.psychologytoday.com/us/blog/the-athletes-way/201601/kids-and-classrooms-why-environment-matters>

In his seminal 1958 book, [*The Poetics of Space*](#), Gaston Bachelard identifies the importance of architectural design—as well as the surrounding landscapes and infrastructure of buildings—on the human psyche. Bachelard contends that our minds thrive in spaces that allow us to daydream, and stagnate in spaces that are depressing or oppressive.

The Cognitive Benefits of Interacting With Nature

https://www.researchgate.net/publication/23718837_The_Cognitive_Benefits_of_Interacting_With_Nature

We compare the restorative effects on cognitive functioning of interactions with natural versus urban environments. Attention restoration theory (ART) provides an analysis of the kinds of environments that lead to improvements in directed-attention abilities. Nature, which is filled with intriguing stimuli, modestly grabs attention in a bottom-up fashion, allowing top-down directed-attention abilities a chance to replenish. Unlike natural environments, urban environments are filled with stimulation that captures attention dramatically and additionally requires directed attention (e.g., to avoid being hit by a car), making them less restorative. We present two experiments that show that walking in nature or viewing pictures of nature can improve directed-attention abilities as measured with a backwards digit-span task and the Attention Network Task, thus validating attention restoration theory.

Impact of Views to School Landscapes on Recovery From Stress and Mental Fatigue

<https://www.sciencedirect.com/science/article/pii/S0169204615002571>

Results demonstrate that classroom views to green landscapes cause significantly better performance on tests of attention and increase student's recovery from stressful experiences. A lack of mediation effect demonstrates that attention restoration and stress recovery are two distinct processes. Implications for school site selection, design and renovation are discussed.

Do Experiences With Nature Promote Learning? Converging Evidence of a Cause-and- Effect Relationship

<https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00305/full>

Nature may promote learning by improving learners' attention, levels of stress, self-discipline, interest and enjoyment in learning, and physical activity and fitness. Nature also appears to provide a calmer, quieter, safer context for learning; a warmer, more cooperative context for learning; and a combination of “loose parts” and autonomy that fosters developmentally beneficial forms of play. It is time to take nature seriously as a resource for learning – particularly for students not effectively reached by traditional instruction.

Might School Performance Grow on Trees? Examining the Link Between “Greenness” and Academic Achievement in Urban, High-Poverty Schools

<https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01669/full>

School greenness predicted math achievement when neighborhood greenness was controlled for, but neighborhood greenness did not significantly predict either reading or math achievement when school greenness was taken into account. Future research should assess whether greening schoolyards boost school performance

Classrooms With Nature Views: Evidence of Differing Student Perceptions and Behaviors

<https://journals.sagepub.com/doi/abs/10.1177/0013916513499583?journalCode=eaba&>

The current study examines differences across multiple sections of a college writing course in two types of identically designed classrooms—those with a view of a natural setting and those with a view of a concrete retaining wall. Results showed that students in the natural view classrooms were generally more positive when rating the course. Students in the natural view condition also had higher end of semester grades, but no differences in attendance were observed between conditions. Such findings suggest that classrooms with natural views offer advantages and also suggest that the inclusion of natural elements in courses could facilitate positive perceptions and better grades.

Green urban landscapes and school-level academic performance

<https://www.childrenandnature.org/research/higher-levels-of-tree-canopy-are-linked-to-higher-school-level-reading-test-scores/>

This study explored relationships between environmental variables (tree cover, vegetated land covers, water) on and around school grounds in an urban area and school-level academic performance. Schools with higher levels of tree canopy tended to have higher reading test scores, lending support for increasing tree cover around schools as a way to improve academic success.

Do Lessons in Nature Boost Subsequent Classroom Engagement? Refueling Students in Flight

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5758746/>

Teachers wishing to offer lessons in nature may hold back for fear of leaving students keyed up and unable to concentrate in subsequent, indoor lessons. This study tested the hypothesis that lessons in nature have positive—not negative—aftereffects on subsequent classroom engagement.

Impact of Particulate Matter Exposure and Surrounding “Greenness” on Chronic Absenteeism in Massachusetts Public Schools

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5334761/>

Chronic absenteeism is associated with poorer academic performance and higher attrition in kindergarten to 12th grade (K-12) schools. In prior research, students who were chronically absent generally had fewer employment opportunities and worse health after graduation. We examined the impact that environmental factors surrounding schools have on chronic absenteeism.

Are young children’s utterances affected by characteristics of their learning environments? A multiple case study

<https://www.tandfonline.com/doi/abs/10.1080/03004430.2016.1211116>

Do experiences with nature – from wilderness backpacking to plants in a preschool, to a wetland lesson on frogs—promote learning? Until recently, claims outstripped evidence on this question. But the field has matured, not only substantiating previously unwarranted claims but deepening our understanding of the cause-and-effect relationship between nature and learning. Hundreds of studies now bear on this question, and converging evidence strongly suggests that experiences of nature boost academic learning, personal development, and environmental stewardship.

Tree cover and species composition effects on academic performance of primary school students

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0193254>

Academic performance data from over 300 schools was examined in relation to tree cover, tree diversity, and tree species around the schools. Findings support previously- documented associations between academic performance and “greenness,” but also found tree cover to be a more pronounced predictor of academic performance than other vegetation types, especially for schools with the highest level of external challenges.

Impact of views to school landscapes on recovery from stress and mental fatigue

<https://aslathedirt.files.wordpress.com/2016/01/li-sullivan.pdf>

Results demonstrate that classroom views to green landscapes cause significantly better performance on tests of attention and increase student’s recovery from stressful experiences. A lack of mediation effect demonstrates that attention restoration and stress recovery are two distinct processes.

Using functional Magnetic Resonance Imaging (fMRI) to analyze brain region activity when viewing landscapes

<https://www.sciencedirect.com/science/article/pii/S0169204617300300>

Over the years, the restorative benefits of the natural environment have been taken seriously. These restorative effects continue to be verified in research from both the psychological and physiological perspectives. The latest functional magnetic resonance imaging (fMRI) technology provides an opportunity to further explore the psychophysiological aspects of these benefits from the natural environment.

Human brain activation in response to visual stimulation with rural and urban scenery pictures: a functional magnetic resonance imaging study.

<https://www.semanticscholar.org/paper/Human-brain-activation-in-response-to-visual-with-a-Kim-Jeong/10de84b6c4d3ef6b011510dc87e1e955c19d0bba>

Human brain activation was assessed in terms of eco-friendliness while viewing still photographs depicting rural and urban surrounding environments with the use of a functional magnetic resonance imaging technique

Neural Bases on Cognitive Aspect of Landscape Evaluation: A Study Using Functional Magnetic Resonance Imaging

<http://www.jneuro.com/neurology-neuroscience/neural-bases-on-cognitive-aspect-of-landscape-evaluation-a-study-using-functional-magnetic-resonance-imaging.php?aid=23244>

Using functional magnetic resonance imaging (fMRI), we show that two kinds of landscape pictures, Japanese traditional architecture/ nature images (JTANs) and modern cityscapes (MCs), have distinct effects on human brain activation. While participants viewed pictures of the above-mentioned landscapes, their brain activity was more prominent in the dorsal than the ventral visual pathway, and activation in the right precuneus was evident during the viewing of the JTAN pictures. Moreover, the cerebellum and hippocampus were activated during the viewing of unpleasant MC pictures. Conclusion: Our results suggest that the dorsal pathway and the right precuneus play important roles in scenery evaluation, while the ventral pathway and the left lingual gyrus are involved in unpleasant emotion generation.

Nature's Relationships : Fractals and Forests

<http://www.freshvista.com/2018/natures-relationships-fractals-and-forests/>

Benefits of Nature Contact for Children

<https://journals.sagepub.com/doi/abs/10.1177/0885412215595441?journalCode=jplb>

This review examines different ways that contact with nature can contribute to the health and well-being of children. Applying the capabilities approach to human development for a broad definition of well-being, it traces research from the 1970s to the present, following shifting research approaches that investigate different dimensions of health. A compelling body of evidence exists that trees and natural areas are essential elements of healthy communities for children. They need to be integrated at multiple scales, from landscaping around homes, schools, and childcare centers, to linked systems of urban trails, greenways, parks, and “rough ground” for children’s creative play.

A green view through a classroom window can improve students’ performance

<https://www.sciencedaily.com/releases/2016/01/160122170932.htm>

High school students perform better on tests if they are in a classroom with a view of a green landscape, rather than a windowless room or a room with a view of built space, according to new research.

Being raised in greener neighborhoods may have beneficial effects on brain development

<https://www.sciencedaily.com/releases/2018/02/180223100626.htm>

A new study shows for the first time that exposure to green space during childhood is associated with beneficial structural changes in the developing brain.

INCLUSION WITH NATURE: THE PSYCHOLOGY OF HUMAN-NATURE RELATIONS

https://cdn.naaee.org/system/files/harmony/files/schultz_nature_connectedness.pdf

Research Shows a Walk in the Park Improves Attention in Children with ADHD

<https://aces.illinois.edu/news/research-shows-walk-park-improves-attention-children-adhd-0>

A study conducted at the University of Illinois shows that children with ADHD demonstrate greater attention after a 20-minute walk in a park than after a similar walk in a downtown area or a residential neighborhood.

Being around trees and other greenery may help teens stave off depression

https://www.washingtonpost.com/national/health-science/study-being-around-trees-and-other-greenery-may-help-teens-stave-off-depression/2018/01/19/252df102-fc92-11e7-ad8c-ecbb62019393_story.html

Exposure to trees and other greenery has been shown to stave off depression in adults, and a new study finds the same may be true for teenagers.

Using Smartphone Technologies to Investigate the Impact of Nature on Mental Well-Being in Real Time

<https://academic.oup.com/bioscience/article/68/2/134/4791430>

Existing evidence on the beneficial effects of nature on mental health comes from studies using cross-sectional designs. We developed a smartphone-based tool (Urban Mind; www.urbanmind.info) to examine how exposure to natural features within the built environment affects mental well-being in real time.

The Key to Better Students Is Getting Them Outside

<https://www.outsideonline.com/2150116/best-schools-teach-more-science-and-math>

What are the Benefits of Interacting with Nature?

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3709294/>

There is mounting empirical evidence that interacting with nature delivers measurable benefits to people. Reviews of this topic have generally focused on a specific type of benefit, been limited to a single discipline, or covered the benefits delivered from a particular type of interaction. Here we construct novel typologies of the settings, interactions and potential benefits of people-nature experiences, and use these to organize an assessment of the benefits of interacting with nature.

The Nature of Americans

<https://natureofamericans.org>

Foundational to these recommendations is the core premise that connection to nature is not a dispensable amenity but, rather, is essential to the quality of life, health, social well-being, prosperity, and productivity of all Americans.

Forest Bathing: A Retreat To Nature Can Boost Immunity And Mood

<https://www.npr.org/sections/health-shots/2017/07/17/536676954/forest-bathing-a-retreat-to-nature-can-boost-immunity-and-mood?sc=tw?sc=tw>

A Dose-Response Curve Describing the Relationship Between Urban Tree Cover Density and Self-Reported Stress Recovery

<https://journals.sagepub.com/doi/abs/10.1177/0013916514552321>

These findings suggest that viewing tree canopy in communities can significantly aid stress recovery and that every tree matters.

What are the merits of a tree canopy?

<https://theapopkavoice.com/merits-tree-canopy/>

Wild and free: Unpredictability and spaciousness as predictors of creative performance

https://www.childrenandnature.org/research/certain-features-of-nature-imagery-can-promote-creativity-in-individuals/?utm_source=Research+Digest+January+2017&utm_campaign=Jan2017+Research+Digest&utm_medium=email

Certain features of nature imagery can promote creativity in individuals

How to Protect Kids from Nature-Deficit Disorder

https://greatergood.berkeley.edu/article/item/how_to_protect_kids_from_nature_deficit_disorder?utm_source=GG+Newsletter+Sept+21%25252C+2016&utm_campaign=GG+Newsletter+Sept+21+2016+&utm_medium=email

Today's kids spend less and less time outdoors, and it's taking a toll on their health and well-being. Research has shown that children do better physically and emotionally when they are in green spaces, benefiting from the positive feelings, stress reduction, and attention restoration nature engenders.

Nurturing Children's Biophilia: Developmentally Appropriate Environmental Education for Young Children

<https://www.whitehutchinson.com/children/articles/nurturing.shtml>

Benefits of Nature Contact for Children

<https://journals.sagepub.com/doi/abs/10.1177/0885412215595441>

This review examines different ways that contact with nature can contribute to the health and well-being of children. Applying the capabilities approach to human development for a broad definition of well-being, it traces research from the 1970s to the present, following shifting research approaches that investigate different dimensions of health. A compelling body of evidence exists that trees and natural areas are essential elements of healthy communities for children.

At Home with Nature: Effects of "Greenness" on Children's Cognitive Functioning

<https://journals.sagepub.com/doi/abs/10.1177/00139160021972793>

The nearby natural environment plays a far more significant role in the well-being of children residing in poor urban environments than has previously been recognized. Using a

premove/postmove longitudinal design, this research rules out the effects of various extraneous variables that have plagued previous studies and explores the linkage between the naturalness or restorativeness of the home environment and the cognitive functioning of low-income urban children. Both before and after relocation, objective measures of naturalness are employed along with a standardized instrument measuring the children's cognitive functioning. Results indicate that children whose homes improved the most in terms of greenness following relocation also tended to have the highest levels of cognitive functioning following the move.

Green spaces and cognitive development in primary schoolchildren

<https://www.pnas.org/content/112/26/7937>

Exposure to green space has been associated with better physical and mental health. Although this exposure could also influence cognitive development in children, available epidemiological evidence on such an impact is scarce. This study aimed to assess the association between exposure to green space and measures of cognitive development in primary schoolchildren. Our study showed a beneficial association between exposure to green space and cognitive development among schoolchildren that was partly mediated by reduction in exposure to air pollution.

How Walking in Nature Changes the Brain

<https://well.blogs.nytimes.com/2015/07/22/how-nature-changes-the-brain/?smid=li-share&r=1>

Measuring connectedness to nature in preschool children in an urban setting and its relation to psychological functioning

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0207057>

The urban environment has been criticized for promoting 'nature-deficit' and 'child-nature disconnectedness'. Keeping in mind the importance of nature exposure and its extensive health benefits, many environmental programs around the world hope to (re)connect children with nature. To evaluate the effectiveness of such efforts, valid tools to measure Connectedness to Nature (CN) are needed but do not exist today, especially for use with pre-schoolers.

Green Mind Theory: How Brain-Body-Behaviour Links into Natural and Social Environments for Healthy Habits

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5551144/>

We propose a Green Mind Theory (GMT) to link the human mind with the brain and body, and connect the body into natural and social environments.

PATTERNS IN NATURE: WHY WE NEED THEM IN THE BUILT ENVIRONMENT

<https://www.terramai.com/blog/patterns-in-nature-and-built-environment/>

Patterns are everywhere in nature. The natural patterns found in nature deeply affect and nurture us. They are imprinted in our physiological-cognitive system and when we spend time in environments devoid of natural patterns, it leads to anxiety and stress which in the short term hampers productivity but in the long term can lead to illness.

How Nature Makes Us Healthier and Happier

<https://www.yesmagazine.org/health-happiness/2017/03/13/what-happens-when-we-reconnect-with-nature/>