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## Contact with Nature can help ADHD children to cope with their symptoms. The state of the evidence and future directions for research.

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### Abstract

Research within the environmental psychology area shows the benefits that Nature contact offers to *typical* children in terms of better mood, better social relations and on improved cognitive functioning. Although many psychological benefits in childhood have been highlighted by researchers from different backgrounds, *atypical* children have scarcely been included in such studies. We refer to children affected by Attention Deficit Hyperactivity Disorder (ADHD). Environments capable of restoring depleted resources such as attention might be of specific help, especially for those who struggle for attention as ADHD children do. Considering the scientific evidence that exposure to Nature offers attentional recovery, as explained by Attention Restoration Theory (ART), we believe that special consideration needs to be given to ADHD children, whose core issue is attention depletion. ART presupposes that psychological restoration occurs while the person feels mentally fatigued. Therefore, ART might constitute the theoretical basis for the clinical aspects of attention in the ADHD frame. The purpose of this mini-review is to offer an overview on what has been done until now on restorative research among ADHD children and indicate new directions for future research by a description of new areas of enquiry and final proposals for policy makers, parents and teachers in order to implement Nature-based interventions in the ADHD field.

**Keywords:** attention deficit hyperactivity disorder; ADHD; attention restoration; Nature-based treatment; children; symptoms severity; restorative environments.

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### 1. Introduction

ADHD is a childhood-onset disease of neurodevelopment characterised by inhibition and self-regulation impairments that are mainly manifested through chronic inattentiveness and impulsive behaviour (hyperactivity). Such disease can persist across adulthood and the entire lifespan (Barkley, 1997; 1998; 2014; Brodeur & Pond, 2001; Vallesi et al, 2013). Although most researchers agree that the causes of the disease are mainly of neurobiological origin, psychological and

environmental factors seem to have a key role in the maintenance of the disease. More specifically, a multi-factored approach takes into consideration cognitive, motivational, behavioural and genetic components as well as self-regulation deficits (Fabio, 2001; Frigerio & Montali, 2018). Interventions are constituted by pharmacological treatments (Maschietto et al., 2012) that often ameliorate the symptoms but, as has been acknowledged, may also lead to side effects such as facial tics, hypertension, and anorexia (Searight et al., 2009), affecting in different forms the daily life of the ADHD child and family. Finally, approximately 30% of medicated children do not respond to pharmacological therapy (Catalá-López et al., 2017; Goldman et al., 1998). In addition to medical therapies, cognitive-behavioural treatments are also implemented. In many cases, the treatment offered is multimodal and includes a combination of pharmacological, psychoeducational and psychotherapeutic interventions. Considering that a growing number of children worldwide has been affected by ADHD (the incidence is around 5-7%; Polanczyk et al., 2014) and the economic impact that it may have (Mazzotta et al., 2008), there is a clear public interest into finding new ADHD complementary and alternative treatments that can both alleviate ADHD symptoms and improve the quality of life of children and families (Searight et al., 2012). Thus, it is necessary to include other perspectives in the current treatments. The perspective that we aim to propose in this article derives from environmental psychology since it recognizes that the complexity of human behaviour, health and well-being are also a result of the physical environment (Gifford, 2014; Glanz, Rimer, & Viswanath, 2008). Such aspects have not been considered yet but deserve a special emphasis on evaluating alternative and complementary treatments for ADHD.

Nature<sup>1</sup> is considered an effective and cost-free way of recovering from daily stress in general (Berto, 2014; Berto et al., 2018) and mental/attentional fatigue in particular (Kaplan, 1995). *Mental fatigue* refers to lack of attention, becoming easily distracted, having difficulty in staying focused on and completing unappealing tasks, as well as in listening to and following directions, feeling exhausted, irritable and leading to a greater inclination to be impulsive, similar to the ADHD symptoms described in the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition (APA, 2013). The activation of mechanisms able to restore attentional capacity is therefore fundamental and one such way is via exposure to natural environments. Contact with Nature mainly activates bottom-up involuntary attention<sup>2</sup>, and since people are not required to focus on specific 'less interesting' stimuli in natural environments, no effort needs to be directed towards suppressing such 'distracting' stimuli (for a more in-depth discussion see: Berto, 2005; Berto, Massaccesi & Pasini, 2008; Berto et al., 2010). Though we are aware of the differences between mental fatigue effects (on an average person) and ADHD symptoms (in a formally diagnosed with ADHD child) this mini-review aims to suggest exposure to natural environments as an alternative and/or complementary treatment for ADHD children.

## 2. Studies on ADHD symptoms

### 2.1. Studies on ADHD symptoms among typical children

Studies assessing the benefits of greenness on cognitive functioning among typical school children have considered both residential and educational setting (Bakir-Demir et al., 2019). Considering the greenness of *residential areas*, Faber Taylor, Kuo and Sullivan (2002) showed that green views from apartment windows potentially reduce both symptoms of Attention Deficit Disorder (ADD) and Attention Deficit Hyperactivity Disorder (ADHD) and, as such, they offer evidence that green views constitute a protective factor among children living in inner cities or in urban areas in general. Similarly, in a sample of children in Germany, Markevych et al. (2014) showed that, as the distance from home to green areas decreased, so did the probabilities of the child presenting symptoms of inattention and hyperactivity. Wells (2000) conducted a study in the USA and had

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<sup>1</sup> In this minireview we refer to Nature (and greenness) to indicate a wider concept of natural environment, i.e. "an environment with little or no apparent evidence of human presence or intervention, and the two terms [Nature and natural environment] been used interchangeably" (Hartig, Mitchell, De Vries, & Frumkin, 2014, p. 208).

<sup>2</sup> Attention can be categorized into two distinct functions: "bottom-up" attention, also known as stimulus-driven or exogenous, and "top-down" attention, also known as goal-driven or endogenous. In natural environments, mostly bottom-up involuntary attention is captured and individuals do not spend energy suppressing distracting stimuli.

similar results. Thus, in ADD (Attention Deficit Disorder) children, symptoms are reduced after moving to a greener area independently of factors such as low income. In addition, in line with previous findings, Amoly et al. (2014), considering parents' and teachers' assessment of children's ADHD symptoms, found that in Spain greenness around residential areas was related to less inattention and hyperactivity and also that this result was not dependent on family income. Similar results were obtained by Lee, Kim, and Ha (2019) who conducted a study investigating the relation between community greenness and neurodevelopment health among children in South Korea. In brief, findings revealed that the greenness of residential neighbourhood was associated with lower problematic behaviour in children, in particular aggressive behaviours and attention problems.

Considering the *educational settings*, Martensson et al. (2009) wondered whether the greenness around the school area could have a positive effect on preschool children's cognitive functioning. Authors conducted a study by assessing the quality of the outdoor environment and the fraction of visible sky from play structures used by children. Then, teachers rated attention level and impulsive behaviour of children during play time in the assessed green areas. Outcomes showed that children spending their recreation in large and integrated outdoor areas which include hilly terrain, shrubbery and trees significantly displayed fewer behaviours characterized by inattention. Similarly, a longitudinal study among Norwegian pre-schoolers spending time outdoors during day-care time revealed that attention skills were supported by outdoor time in preschool (Ulset et al., 2017). The study had also predictive value since authors stated that spending time outdoor during preschool protects against developing attention deficit hyperactivity disorder in the future.

Dadvand et al. (2015) conducted a longitudinal study in Spain that merged both *educational and residential settings*. Authors showed that school-aged children improved their attention and working memory during the year as levels of vegetation around home, routes to school and school area increased. Accordingly, Donovan et al. (2019) conducted a study in New Zealand on 49.923 children born in 1998. Their findings revealed that a lower risk of ADHD was associated with increased minimum greenness and rurality (see also Markevych et al., 2018). Other findings that reinforce and extend previous research on ADHD symptoms conducted among typical children are those revealed by Yang et al. (2019). Authors evaluated the association between greenness surrounding schools or day-care centres and ADHD symptoms reported by parents or guardians through a population-based cross-sectional study based on a total number of 59.754 children aged between 2 and 17 years. Results suggest the existence of a beneficial association between greenness and ADHD symptoms.

## 2.2. Studies on ADHD symptoms among ADHD children

A few studies in restorative research included children affected by ADHD, some of them are correlational, while two are quasi-experimental field studies. Regarding the correlational studies, an example is the one conducted by Faber Taylor, Kuo and Sullivan (2001), who showed that ADHD children who usually play in green settings are more likely to experience less severe attention deficits and, the greener the child's play area is, the stronger is the correlation. A few years later, the same authors conducted an online survey involving children affected by ADHD. From parents' reports, it resulted that "children who regularly play in green outdoor settings experience milder ADHD symptoms than their counterparts playing indoors or in built outdoor settings" (Faber Taylor & Kuo, 2011, p. 296). Moreover, authors tried to differentiate environments between ADD (attention deficit only) and ADHD (attention deficit with hyperactivity) groups. Findings demonstrated that children diagnosed with attention deficits only improved after playing both in grassy areas with big trees and grass open lawns whereas hyperactive children improved only after playing on open grass areas.

To the best of our knowledge, only two quasi-experimental field studies have been conducted in the environmental psychology framework among children affected by ADHD. One took place in the USA by Faber Taylor and Kuo (2008), who conducted single blind controlled trials in a within-subjects crossover design study. The authors exposed the ADHD children to three different outdoor environments: a city-park, an urban residential area and a downtown area. Their aim was to evaluate the effects of a slow paced twenty minute individually guided walking in such environments during different sessions on attention and impulse control. Participants (N = 17)

aged seven to twelve, were pharmacologically treated. Attention and impulsivity were measured after walking in each environmental condition by administering four objective tests. Findings revealed that children concentrated better after walking in the natural condition (an urban park) compared to the two built conditions, suggesting that the amelioration might be compared to medication effect (e.g. methylphenidate peak effect of extended release). The authors stated that Nature “might serve as a safe, inexpensive, widely accessible new tool in the tool kit for managing ADHD symptoms” (Faber Taylor & Kuo, 2008, p. 402).

The second quasi-experimental field study (Van den Berg & Van den Berg, 2010) conducted among children affected by ADHD took place in the Netherlands and was aimed at testing and observing the participants in a natural (a wooded area) and an urban setting. Authors assessed emotions, cognitive functioning and behavior. Participants were medicated and their age ranged between nine and seventeen years of age. Outcomes showed that woods were perceived as more restorative as compared to the town and that children could better concentrate in the woods than in the town. Their behaviour was less impulsive and inattentive in the woods. Moreover, more positive feelings were reported by the children in the woods than in the town.

### 3. Four gaps to fill in literature on ADHD children

Although studies on ADHD children offer some evidence that Nature contact ameliorates symptoms severity, much more rigorous evidence through experimental studies (e.g. pre and post treatment assessment, within subject design, longitudinal study) is needed to fill some gaps in literature.

The *first gap*. Special attention to the natural settings needs to be given in order to choose different natural scenarios (e.g. “blue” settings such as rivers, lakes and sea or different types of “green” settings) that are objectively differentiated (Martensson et al., 2009). In fact, the natural settings implemented in previous quasi-experimental studies relate to examples of urban nature or wooded areas while, for instance, no experimental evidence exists on the effects of being exposed to a large open field that may be likely to offer a deep vision of field characterized by high prospect (Appleton, 1975; Di Carmine, 2019; Gatersleben & Andrews, 2013). This aspect needs to be addressed by future research since correlational studies suggest that hyperactive children seem to benefit from the presence of open grassy lawns (Faber Taylor & Kuo, 2011), as recently shown also by Di Carmine (2019), who suggests that big trees in grassy lawns may probably constitute an obstacle and an unnecessary refuge for children, probably because trees limit children’s need to be in constant movement. Such an outcome deserves more scientific attention since it seems in accordance with the factor *compatibility*, part of the ART framework, which explains the restorative potential of an environment on the basis of the correspondence between the child’s purposes and the support or opportunities offered by the environment to fulfil them (Kaplan, 1995).

Researchers should implement different types of Nature categorized through objective data of the physical environment to examine which specific characteristics lead to recovery (Collado, Staats & Sorrel, 2016; Martensson et al., 2009). Moreover, as suggested by Collado and Staats (2016), the Nature tag used in environmental psychology needs to be broadened, not only in terms of types of natural environments but also in terms of which senses are assessed to evaluate the restorative potential of that environment. In fact, current literature is mainly focused on the sense of sight while the human-Nature transactions are more complex since humans are multisensory. “The multi-sensory aspect of nature experiences is crucial because monotony of stimulation can be a source of stress and multimodal sensory input itself can drive positive mental states such as tranquillity. Indeed, it has been shown that stimulating multiple senses at the same time may possibly lead to additive beneficial effects of nature experiences” (Franco, Shanahan & Fuller, 2017, p. 2). Further investigation among ADHD children is needed in order to evaluate and measure whether Nature exposure can be even more effective and intense through other senses such as the sense of hearing and the sense of touch.

Future research should investigate the difference between *nearby or everyday* Nature (Cox et al., 2017; Wells & Evans, 2003) and *extraordinary* Nature (Joye & Bolderdijk, 2015) among ADHD children. We argue that, because ADHD children struggle for attention, they might need a more intense dose of Nature to replenish, maybe for a longer beneficial effect (Collado et al., 2015; Cox

et al., 2017; Shanahan et al., 2016). It is worth examining whether extraordinary Nature is awe-evoking (Collado & Manrique, 2019) also for this clinical population and, as such, its relation with symptoms alleviation.

Another line of research including the natural environment and ADHD makes reference to the possibility to be restored by exposure to Virtual Nature. In challenging times, such as during Covid-19 emergency, access to public green areas may be restricted, thus becoming an important limitation for hyperactive children and this limitation is further exacerbated by the many hours spent at a computer screen for online teaching. At this purpose, future research could address whether the implementation of virtual extraordinary Nature is effective in reducing stress and anxiety and promoting cognitive functioning among ADHD, although screens need to be used with caution due to possible side effects (Berto, 2014; Hutton et al., 2019; Liszio, Graf & Masuch, 2018; Valtchanov, Barton & Ellard, 2010).

Another field that deserves investigation among ADHD children is the concept of Nature as a containing and holding space, or the theory of Nature Nurtures (Hordyk, Dulude & Shem, 2015). In this case, ADHD is seen as “patterns of disruptive childhood behaviour emanate from interactive dynamics within the family and a lack of psychological well-being in children” (Rafalovich, 2015, p. 79) rather than a disorder of neurobiological and genetic origin. However, what is of interest in this article, is that Nature can become a caregiver substitute, a source of relational attachment when caregiver’s holding (Winnicott, 1965) and containment (Bion, 1963) is absent or weak. Nature promotes cognitive functioning (Attention Restoration Theory; Kaplan, 1995) and stress-reduction (Stress Recovery Theory; SRT, Ulrich, 1983) simply establishing an affiliation with Nature (Barbiero & Berto, 2018; Cheng & Monroe, 2012; Hinds & Sparks, 2008). In this way we argue that adopting a Nature-based treatment aiming at nurturing the child as in the mother-child relationship, as demonstrated by Hordyk et al. (2015), could be an effective intervention for improving the quality of life and the well-being of ADHD children in a psychodynamic frame, that at the same time does not exclude the recognized advantages in terms of cognitive functioning (Korpela, Kyttä & Hartig, 2002).

Another future line of research might address the educational settings (Carrus et al., 2015). Researchers could evaluate whether the benefits of spending the recreation outdoors, the so called “green breaks” (Amicone et al., 2018; Chawla et al., 2014; see also Weeland et al., 2019) and outdoor pedagogies might be effective also for ADHD children (Kuo, Browning & Penner, 2018; Otte et al., 2019).

*The second gap.* Future studies on restorative research should address the importance of the (built) outdoor and indoor environment. Regarding the built outdoor, that is the urban environment, researchers should take a closer look at historical environments. There is some evidence that exposure to urban settings rich in high levels of architectural variation (Lindal & Hartig, 2013), among other details that belong to some historical architectural styles, promotes restoration, more than exposure to urban settings (Bornioli, Parkhurst & Morgan 2018a; Bornioli, Parkhurst & Morgan, 2018b; Fornara, 2011; San Juan, Subiza-Pérez & Vozmediano, 2017; Scopelliti et al., 2019; Van den Berg, Joye, & Koole, 2016; Xu, Zhao & Ye, 2018). Although the benefit of Nature contact is widely recognized in literature, we have to admit that urban children spend their time in the inner city, and therefore emerges the importance to choose on daily basis in which areas their attention is sustained. Furthermore, this seems an important aspect that deserves the attention of policy makers and those who aim to design sustainable cities.

Next, regarding the indoor spaces, future research should address how to promote attention functioning in those settings that ADHD children attend on daily basis, in which they spend most of their time and that constitute an essential promoter of learning and academic achievements, such as day-care centres and schools as well as home environments. Although being affiliated with Nature cannot be reduced to taking Nature indoors (Browning, Ryan & Clancy, 2014), a practical form of taking advantages of Nature for ADHD children in indoor school settings (and not only) is through green walls with living plants in classrooms, since there is some evidence of their restorative potential (Van den Berg et al., 2017). We have to recognize that children spend most of their time indoors rather than outdoors. Therefore, a research question to be addressed would be whether indoor environments foster or deplete attention among ADHD children. In this respect, it is worth considering Biophilic Design (Kellert et al., 2008): “an applied science, aimed at

planning artificial spaces that reflect biophilia, the innate tendency of human beings to seek connections with Nature. It is well known that the application of Biophilic Design reduces stress, stimulates creativity and clear thinking, improves physical and psychological well-being and accelerates healing” (Bolten & Barbiero, 2020, p. 12). In other words, biophilia is an innate tendency that is inherently part of our equilibrium and functioning, since as a species we spent most of our existence in natural, rather than urban, environments. This aspect opens up a new perspective for researchers to examine, through a rigorous methodology, to see if being exposed to restorative indoor environments which recall our biophilia ensures psychological restoration (Berto, 2019; Berto, Maculan & Barbiero, 2020) also among ADHD children, with a possible impact on academic achievements, if considering school settings.

*The third gap.* More studies are needed to better explore, on a longitudinal design, the relation between the frequency of contact with Nature in daily and afterschool activities and cognitive functioning as well as how the frequency of contact with Nature is influenced by the family’s composition, family’s Nature connectedness and frequency of contact with Nature (Carrus et al., 2017; Collado et al., 2015; Di Carmine, 2019; Faber Taylor & Kuo, 2011). While there is evidence of cognitive benefits deriving from Nature exposure among ADHD children, research needs to determine the amount of a minimum effective dose of contact with Nature (Cox et al., 2017; Shanahan et al., 2016). In other words, we refer to the minimum length of exposure able to ensure psychological restoration among ADHD children and the frequency of exposure essential to guarantee a long-lasting effect and able to improve the daily quality of life of children and families affected by ADHD. In this respect, an insight that can drive future investigations derives from previous studies which implemented a twenty minute intervention that resulted in a statistically significant improvement of attention (Di Carmine, 2019; Faber Taylor & Kuo, 2008). However, more rigorous research through experimental studies is needed to address this aspect, also in relation to its frequency (Shanahan et al., 2016).

*The fourth gap.* It is important to consider the social context of children’s restoration (Collado & Staats, 2016). Children affected by ADHD are often impaired in terms of social relations since they are affected by a malfunction of joint attention, which is vital to social competence during childhood and the entire lifespan (Marotta et al., 2013). Considering that exposure to Nature has proved to be effective for pro-social behaviour (Carrus et al., 2015; Chawla et al., 2014; Hordyk et al., 2015; Myers, 2012), this aspect needs to be addressed in future research within the ADHD population (often in comorbidity with opponent-defiant disorder) since improvements in social relations may constitute an improvement in the quality of life and a reduction of public costs (Mazzotta et al., 2008).

#### **4. Conclusions**

This mini-review aims to relate and extend the attention restoration construct to attention clinical issues, such as those regarding ADHD. Based on Attention Restoration Theory (Kaplan, 1995), attentional recovery is possible when individuals are exposed to natural restorative environments. Such theoretical framework seems fitting within ADHD clinical manifestations (APA, 2013). As suggested by the literature considered in this article, there is already some scientific evidence that being exposed to Nature leads to recovery among ADHD children (Di Carmine, 2019; Faber Taylor et al., 2008; Van den Berg & Van den Berg, 2010; Weeland et al., 2019). An integrative framework, based on a holistic perspective between clinical and non-clinical aspects of attention, could be conceptualized to explore the impact of Nature contact on attention depletion within the ADHD framework. Accordingly we suggest: 1) to examine attention through a continuum from *attentional fatigue* to *attention restoration* obtainable through the psycho-physiological restorative process (Barbiero & Berto, 2016; Herzog et al., 1997), 2) to let Nature be a buffer from daily demands amongst ADHD children (Wells & Evans, 2003).

We address this mini-review not only to researchers, but also to those “surrounding” ADHD children, i.e. teachers, school directors and practitioners, and, in particular, parents, to inform them of the benefits that Nature contact offers to alleviate their children’s symptoms and consider that Nature “might serve as a safe, inexpensive, widely accessible new tool in the tool kit for managing ADHD symptoms” (Faber Taylor & Kuo, 2008, p. 402). However, at this point, a social and cultural consideration of ADHD is worth mentioning (Berger et al., 2018; Lange et al., 2010).

In modern society, alienated from Nature (Louv, 2005; 2009) and dehumanized as part of that alienation's implications (e.g. the videophilia; Zaradic & Pergarms, 2007), as well as sedentary activities conducted indoors more than outdoors, the abuse of medications, the unnatural raising of babies with low-contact, the reduction of breast-feeding, unnatural-modified food etc., we are no longer used to think of Nature neither in terms of health (in a holistic sense) nor in terms of physiological needs. This unsustainable vision of life may affect also ADHD children, since paying attention (i.e. to focus and sustain) is something learnable in early stages in which both the social and physical environment play a key role. Attention needs to be promoted and fostered when its physiological development occurs, during early and later infancy. Hence the importance of encouraging Nature contact from early infancy, as it constitutes a prevention tool and a protective factor against ADHD and other clinical issues (Ulset et al., 2017) as well as constituting part of a physiological developmental milestone able to prepare the child for a healthy developmental trajectory, a concept in accordance with the topical bio-psycho-social concept of health (WHO, 2014). This aspect also reminds us that, because the aetiology of ADHD is still unclear, and environmental factors associated with ADHD (prenatal included) are estimated between 10 and 40% of variance (Beydoun & Saftlas, 2008; Sciberras et al., 2017), we do not know to what extent being alienated by Nature (both mother and offspring) leads to the development or to the persistence and the severity of the disease (Van den Berg & Van den Berg, 2010). However, because no side effects are expectable through Nature contact (apart from biophobia; Ulrich, 1993) and, on the other hand, the planet might also benefit from pro-environmental behaviour (Collado et al., 2015), researchers should investigate how to promote Nature contact to children and families affected by ADHD. Moreover, we hope that practitioners may include Nature contact in their prescriptions and extend them to ADHD children, as recently and successfully done in the "Park prescription program" by a group of paediatricians and practitioners in the USA (Seltenrich, 2015).

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