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How does Psychological Restoration Work in Children? An Exploratory Study

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Abstract

This study investigates three issues concerned with psychological restoration in children, specifically whether children perceive the difference between the restorative value of a natural and a built environment; whether the perception of restorativeness affects children's attentional performance; how children feel to be connected with Nature. To this aim, 48 children age 9-11 years participated in a within-subjects study; children filled in the Perceived Restorativeness Scale-children (environmental preference included) and the Connectedness to Nature Scale-children, and performed the Continuous Performance Test in three different conditions: 1-in the classroom after the practice of Mindful Silence; 2-in the school playground after the school break; 3-in an alpine wood after a walk. In addition to the self-report assessments and the measurement of attentional performance, the children's physiological condition was assessed by measuring some basic physiological parameters. From results it emerges that though children's connection to Nature doesn't vary among conditions, they can discriminate among environments with different degree of restorativeness (assessments were made on setting characteristics and activities), and the perception of restorativeness keeps pace with the performance at the attention test and the preference evaluation. Results are in agreement with Kaplan's Attention Restoration Theory (1995) and the fascination/meditation hypothesis (Kaplan, 2001).

Keywords: Children; Attention restoration; Perceived restorativeness; Connectedness to nature; Mindful silence

Highlights

Do children perceive the difference between the restorative value of a natural and an artificial environment?

Does the perceived restorativeness of Nature affect children's performance in directed attention test?

Do children feel to be connected with natural environments and, if so, to what extent?

Introduction

As a species we have an inherent affiliation with the natural environment, called biophilia [1,2]. Biophilia is «the innate tendency to focus upon life and lifelike forms and in some instances to affiliate with them emotionally»[3]. Human tendencies to love and take care of Nature are affected by attention, i.e. the ability to focus on natural stimuli effortlessly (actually to be fascinated by Nature) [4], and empathy, i.e. to join emotionally to the various life forms, and to participate in their condition. Exposure to the natural environment may facilitate the development of emotional bonds and identification with it, which may in turn lead to positive psychological and physical well-being [5] and to the formation of positive attitudes and behaviours towards the natural environment [6]. This raises important questions about the role of exposure to natural environments in childhood and whether or not this may influence individual attitudes towards Nature and the potential restorative benefits deriving from exposure to Nature. Intimate contact with the natural world, especially during childhood, has been suggested to be essential in forming meaningful bonds with and promoting positive values towards the natural environment [7-9], as well as being crucial for harmonious personality growth [10-13]. Loss of contact with the natural world, typical of our modern age, can cause serious damage to children's physical and mental development, impoverishing their sensory abilities, making them less effective and withering thought and spirituality [14,15].

The importance of visual contact with Nature extends beyond actual aesthetics and includes a range of benefits in terms of enhancement of physiological well-being [16,17] and recovery from mental fatigue [4,18,19]. Natural environments are assumed to attract involuntary attention, the kind of attention that does not demand mental effort and is attracted to stimuli having innately fascinating qualities [4]. In Kaplan's Attention Restoration Theory (ART), this type of involuntary and effortless attention, that can derive from many sources (process or content) and can be conceptualised along a dimension from hard to soft, has been referred to as fascination [for more details see 4]. Fascination is one of the characteristics of a restorative environment, which provides the opportunity for recovering depleted directed attentional capacity; in addition to fascination, a restorative environment should have certain other characteristics, such as being away, extent, and compatibility [4].

Recovering from mental fatigue requires that one be some place other than the source of the fatigue (being away), the place should be large enough so no boundaries are evident (extent), and compatible with one's inclinations (compatibility). Kaplan [20] also proposed a hypothesis that fascination and meditation are crisscrossed. Nature is

definitely the main source of fascination; unfortunately nowadays contact with Nature is less and less frequent and this is a risk in particular for children, who progressively lose sensitivity to natural environments [13,21]. Children's "disconnection" to the natural world is both complex and worrisome [13]; however the fascination process is learnable: through meditation practice you can learn how to work in involuntary mode [20]. Actually meditation can help individuals managing their attentional resources more effectively, in fact meditation involves avoiding unnecessary costs in terms of expenditure of directed attention, and it enhances the effect of restorative opportunities [20]. In this way directed attention is not only recovered but the subject also becomes more focused on the ongoing task. With regard to this, recent studies [22,23] have shown that mindfulness meditation practice produces long-lasting effects on children's attentional performance.

The aim of this study

Although there is plenty of evidence to show that exposure to natural environments has positive effects on adults [4,17,19,24-28], research into children's perception of restorativeness and the potential restorative effects of natural environments for this population is still at the beginning. However the pattern emerging from the literature suggests that a child living in a place with more Nature is likely to benefit with respect to his/her cognitive functioning or attentional capacity [29-30]. As for Tennessen and Cimprich's college students [19], i.e. those with natural views from their dormitory windows had better attentional capacities, a Swedish study showed that pre-school children are more focused when they play in a green area than in a purpose-built playground area [31]. Benefits in attentional performance were also observed for children with Attention Deficit Disorder (ADD) or Attention Deficit Hyperactivity Disorder(ADHD) [31-34]. The capacity to direct attention is a crucial component in everyday activities for children as well [35,36]; the presence of vegetation actually promotes play, better motor coordination and attentional capacities among pre-school children [34]. A number of studies have examined the relationship between different types of environments varying in levels of Nature and children's attentional capacity [34,37,38] though without including an assessment of the restorative level across environments. Only Bagot [39] asked 8 to 11-year-old children to assess the restorative value of two familiar environments: the school playground and the school library. This study can be considered the first attempt to encompass children's perception of restorativeness with a self-report instrument, though the author was more interested in verifying the psychometric characteristics of the scale used rather than their ability to discriminate the restorative value of places [40].

In this study we want to go further covering children's perception of restorativeness in the first place, then the relationship between perceived restorativeness and attentional performance and finally assessing children's connectedness to Nature. The traditional ways in which children once connected with the natural world (curious exploration, free play outdoors, experiences with Nature) have quietly faded, if not disappeared from their lives [13,41], therefore in this study the child-Nature connection was not taken for granted, rather assessed explicitly. To this end, we tried to address the following research questions in a group of primary school children not diagnosed with attention deficits: Does psychological restoration work in children in the same way as it does in adults? Are these children able to perceive and discriminate the restorative value of environments? Is exposure to restorative environments beneficial to children's directed attention? Do primary school children feel connected to Nature? Finally, the present study tests also Kaplan's [20] fascination hypothesis comparing the effect of mindful silence training and exposure to Nature on children's attentional performance.

The first step useful to address these questions was to find a way to measure perceived restoration of physical environments and connection to Nature in children, in order to explore the relationship between these two constructs. Connection to Nature is the extent to which people feel to be a part of the natural world, viewing themselves as belonging to the natural world as much as it belongs to them [42]. Connection to Nature is a stable construct in adults, one either feels connected or not, regardless of where one is when filling the Connectedness to Nature Scale (CNS) [42]. The aim of our study was to verify whether the same construct is also stable in children. On the contrary, the perception of restorativeness should vary according to the place degree of naturalness; therefore a second aim of the study was to verify whether children discriminate between the restorative value of different settings, and whether this perception concerning the settings and the activities occurring there can accordingly affect children's attentional performance.

To accomplish these aims, a revised version of the Perceived Restorativeness Scale (PRS) [43-45], and of the Connectedness to Nature Scale (CNS) [42] were adapted to children's experience (PRS-ch and CNS-ch). The two scales were administered to children from a primary school in three settings with varying degrees of naturalness. To Kaplan's ART [4] the perception of the restorative value of a physical setting cannot be without considering activities that usually take place there. This is particularly true with children [39] and field studies [46]. Therefore in this study children were asked to fill in the scales in: 1) a built environment: the classroom after the practice of Mindful Silence (MS); 2) a mixed environment with both artificial and natural elements: the school playground after play-time (PT); 3) a totally natural environment: an alpine wood after a walk (AW). Put in this way, settings and activities seem apparently to overlap and confound; this is not a methodological issue easy to address, however to reduce confounds (between the effects of settings and activities) the self-rating scales were carefully devised in a pilot study [47]. Each item was tailored for 9-11 years old children in order to have them focus whether on the physical characteristics of the place or the activities taking place there (PRS-ch), and on their personal relation with Nature (CNS-ch). Despite the potential confound, activities were added to the design in order to test the effects of three different "restorative" experiences (MS, PT, AW) on attentional performance [18]. To this end children will be administered the Continuous Performance Test (CPT).

Though literature shows effects on children's attention after 20 minutes exposure to Nature [32], here attention will be assessed after 90 minutes activities: psychological restoration is a process, not an instant reaction. If children are able to perceive the potential restorativeness of an environment from its physical characteristics, we would expect them to consider the wood as the most restorative of the three physical settings. On the contrary, we would expect the classroom to be perceived as the least restorative, owing to the total lack of natural elements. Environmental preference is also assessed in the PRS-ch, as a separate construct. Adults usually prefer natural environments to mixed or urban environments. However, things could be different for children; they might actually prefer the school playground because of the activities they can do there during play-

time. In this case environmental preferences could be affected more by the activity than by the physical characteristics of the place. Play-time is an important aspect of children's school day; accordingly we might expect to find a preference for the playground over the classroom and even over the wood. The children were not «completely free» to do as they liked in the wood, on the contrary, they were guided. In particular, during the walk they were taught to observe the natural elements present along the trail, to smell and touch the wood and to listen out for animals. From this perspective the walk felt more like a lesson, with the difference that it took place in a totally natural environment. The walk in the wood was planned with the aim of evoking fascination in the children, in order to verify whether fascination – i.e. involuntary attention – [4] by exposure to Nature affects children's directed attention in the same way as in adults. To this end children's attentional performance was assessed in the wood and compared to the other two settings, playground and classroom, using a tailored version of the Continuous Performance Test [22]. However, fascination can also be evoked by the practice of Mindful Silence [23], i.e. by an activity that cultivates involuntary attention [20]. From this perspective the experience in the wood and the practice of Mindful Silence, though in the classroom, could have the same effect on children's attentional performance. Nevertheless, it is interesting to verify how free play in the playground can affect children's attentional performance. In addition to connection to Nature, restorativeness and preference assessments and the measurement of attentional performance, the children's physiological condition was assessed by measuring some basic physiological parameters such as systolic and diastolic blood pressure and heart rate. In fact a restorative experience offers also a range of benefits in terms of physiological well-being lowering the arousal level [16]. The present study was carefully devised in order to compare settings and activities that are seemingly not comparable; taking a few methodological notices, this exploratory within-subject design will allow us to speculate on the effects three such different activities in as many different settings might have on the same children.

Method

Participants

A total of 48 children from a primary school in Aosta (Italy) participated in the study (19 males and 29 females, aged 9-11 years). All parents gave their informed consent for their children to participate.

Measurements

Two self-report instruments and a performance task were administered to the children and physiological parameters were measured (systolic and diastolic blood pressure, heart rate).

The perceived restorativeness scale-children

The Perceived Restorativeness Scale-children (PRS-ch) is a scale we tailored for school children [48]. It is based on the ART [4] and on the adult version of the PRS [27,44]. The PRS-ch measures the individual perception of the restorative value of a place; it consists of 17 items measuring the restorative factors being away, fascination, coherence, scope and one item measuring environmental preference (Figure 1). The restorative value of a place is given by the summary score of the 17 items. Judgements are made on a scale of 0 to 4, where 0="completely disagree" and 4="completely agree".

	Perceived Restorativeness Scale-children
1	In this place I don't think at my worries.
2	In this place everything is just where it should be.
3	This place is interesting.
4	In this place I think about other things, not everyday things.
5	In this place interesting things happen.
6	In this place I am free to play, run and move.
7	In this place I can relax mentally and physically.
8	This place is big enough to be explored.
9	In this place I don't think about things I have to do.
10	This place awakens my curiosity.
11	In this place nobody tells me what to do or think.
12	In this place I only think about things I like.
13	In this place there are lots of things to discover.
14	In this place there are lots of things that awaken my curiosity.
15	In this place it is easy to see what's around me.
16	In this place I don't get bored.
17	In this place everything seems to have its own place.
18	I like this place (Preference item).

Figure 1: English version of the PRS-ch.

The connectedness to nature Scale-children

The Connectedness to Nature Scale-children (CNS-ch) is based on Mayer and McPherson Frantz's scale [42]; to make it child-friendly we made up a scale of 7 items designed to measure the extent to which children feel a part of the natural world (Figures 2), i.e. children's sense of oneness with the natural world, sense of kinship with animals and plants, and sense of equality between the self and Nature. The connectedness to Nature score is given by the summary score of the 7 items. Judgements are made on a scale of 0 to 4, where 0=never and 4=always.

Connectedness to Nature Scale-children	
1	I feel connected to the natural world around me.
2	I feel I am part of the same world as the plants and animals.
3	I think animals are intelligent.
4	I feel connected to plants and animals
5	I feel I belong to Nature and Nature belongs to me.
6	I feel part of the natural world.
7	I feel part of the natural world like a tree is a part of the forest.

Figure 2: English version of the CNS-ch.

The continuous performance test

The Continuous Performance Test (CPT) [49] was used to measure the children's attentional performance. The CPT is a pencil and paper test comprising three sub-tests containing long strings that differ in terms of the order of characters in the string, character size and the spaces between the characters. The children were required to find three given contiguous letters in each string (Figure 3). The test can be considered a validated measure of sustained attention and inhibition in children, and though it is not sensitive to learning effect [22,49] a different version of the CPT (i.e. novel letter strings) was administered each time.

Sub-test 1
B W O Y F Z O U F R B F Z B K T E I P D
A M Q X L F Z A Q Z A F U J F Z B J R S
V I P N T G F Z B W C H N R K F Z Q F R
Sub-test 2
A Q X F Z B I S D F Z F O T W L Q V F Z M B L V P I F Z B H
D O G K W R E F Z B N H S O J T X A F Y Q U F Z B N W F Z
L R F Z P I F Z B T J X D F O M K S F Z V X D Z P G O Q W G
Sub-test 3
VFZOHNIKLFZDSFEJSFZBGAYQCBFWQRFZBTEJZSPXDZTAFZBEWUDGL FZBFPFZ
FZBKGLRFZKMBXIOWFZBHYJFZBPCYFATSAFZWVIFEHOXQDFZGLSCAG NHNGSO
FZYLFJDFZBZHBVFZWFEIJSWEQUFZBXUFWRDVLFZBRPBTRVAFZMKTYF ZBQGM

Figure 3: Example of the three sub-tests making up the Continuous Performance Test. FZB is the sequence to be marked here.

Physiological measures

Heart rate and systolic and diastolic blood pressure were measured using the M6 Comfort Omron digital blood pressure monitor (Omron Healthcare Co., Ltd., Kyoto, Japan).

Experimental conditions

The children were assessed in three different conditions: 1) in the classroom after practicing Mindful Silence (MS); 2) in the school playground after play-time (PT); 3) in the alpine wood after a walk (AW). The settings and activities were as follows.

Mindful Silence

In the Mindful Silence condition (MS) children underwent a mindful silence training in their classroom. The training was held by the teacher who was previously got used to this practice. By the way, neither children were completely new to this practice; in fact it happened the teacher used this technique to help them relaxing. First, the children were invited to sit down on the floor, each on their own cushion, in silence. After a minute of silence, they were invited to become aware of the breathing process, keeping their attention on how the air makes its way through the body, and to focus on the sensation the air evokes. In order to compare the effects of this experience in the classroom with the AW and PT conditions, the children took part in one 90-minute MS training session.

Play-time

In the play-time condition (PT) the children were in the school courtyard, a playground area with a green area and some small trees. During the daily break, children are free to play under the teachers' seemingly detached supervision. In order to make comparisons with the other two experimental conditions (MS and AW), break was made a more salient feature of the children's school day lasting 90 minutes.

Alpine wood

In this condition (AW) the children were taken into the alpine wood closest to the school. The wood is a completely natural environment mainly characterized by conifers and a wide, clearly-marked path with several benches down the sides. Children were accompanied by their teacher who led them into the wood and taught them to focus their attention on different aspects of the wood in order to stimulate their senses. The experience in the wood lasted 90 minutes in order to be comparable with the other two conditions.

Procedure

Measurements were performed in the settings at the end of each activity: mindful silence, play, and walk. Measurements were taken by children's teachers and all children were tested at the same time. Physiological parameters were recorded after the activities whereas the PRS-ch, the CNS-ch and the CPT were administered only at the end. The order of administration of the scales and the test was randomized among children across conditions in order to avoid order/sequence effects.

Since activities were rather different from one another, physiological parameters were assessed after an interval of ten minutes at the end of each activity in order to assess the child's parameters "at rest". This interval was particularly necessary in the PT condition where children had just finished a period of free play. For each child the systolic and diastolic blood pressure and heart rate final value was the summary value obtained from three measurements recorded in a space of time of about 90 seconds [50]. In the CPT and self-rating scales completion children were assisted by the teachers.

Data analysis

First, repeated measures analyses of variance (ANOVAs) were run to explore differences among measures (self-report measures: CNS and PRS; objective measures: physiological parameters; performance measure: CPT) within each condition: Play-Time (PT), Mindful Silence (MS), a walk in the wood (AW), in a within-subjects design. Eta-squared ($\eta 2$) was computed to estimate the effect size. When a significant within-subjects effect was found, indicating that at least one of the three conditions differed from another one, means comparisons were run to compare pairs, with Bonferroni correction.

Second, mixed ANOVAs, with the condition as the within-subjects factor and gender as the between-subjects factor, were run to explore the interaction between condition and gender. The interaction between condition and class was also explored with a mixed ANOVA.

Results

In Table 1 the descriptive, the F and related p-values, and η2 of each measure (PRS, CNS, CPT and physiological parameters) are given for the three conditions (PT, MS, AW).

Analysis of self-report measures

PRS-children scores

The PRS scores were considered to verify any differences in the perceived restorativeness in the three conditions (PT, MS, AW). Reliability evaluated with Cronbach's Alpha was good (.79). As shown in Table 1, PT was perceived as the least restorative condition, followed by the MS, and by the AW; repeated measures ANOVA showed a significant effect of condition. Mean comparisons showed that scores differed significantly for each pair of conditions ($p < .001$ for each of the six comparisons).

Measures	PT	MS	AW	F	Df	p-value	η^2
PRS	1.97 (0.7)	2.42 (0.5)	3.33 (0.5)	130.96	3,114	p < .001	0.775
CNS	2.69 (0.7)	2.83 (0.8)	2.79 (.8)	2.593	2,78	n.s.	0.062
PREF	2.39 (1.42)	2.81 (1.11)	3.81 (0.51)	33.3	3,11	p < .001	0.47
MinBP	66.3 (8.9)	61.43 (4.9)	62.83 (6.0)	9.214	2,78	p < .001	0.361
MaxBP	103.08 (12.2)	97.85 (8.95)	98.18 (8.0)	8.461	2,78	p < .001	0.178
HR	86.53 (9.1)	71.95 (9.0)	72.92 (6.2)	116.101	2,78	p < .001	0.749
CPT scores	16.68 (0.9)	17.28 (.55)	17.49 (0.4)	24.183	2,78	p < .001	0.383
CPTtime (in s)	101.7 (21.3)	78.82 (12.1)	62.2 (5.9)	98.455	2,78	p < .001	0.716

Note: Conditions: PT (Play-Time), MS (Mindful Silence), AW (walk in the alpine wood). Measures: PRS (Perceived restorativeness Scale), CNS (Connectedness to Nature Scale), PREF (environmental preference), MinBP (minimum blood pressure), MaxBP (maximum blood pressure), HR (heart rate), CPTscores (correct responses), CPTtime (time of performance).

Table 1: Mean values and standard deviation (in parenthesis) of each measure, and results of repeated measure ANOVA across the three conditions.

The place x gender and place x class interactions were explored with two mixed ANOVAs, with the condition as the within-subjects factor (3 levels: the 3 conditions) and gender (or class) as the between-subjects factor. No significant interactions were found neither in the model with the gender nor in the model with the class. This means that boys and girls and 4th and 5th graders perceived the restorativeness of the conditions in the same way. In fact, these models only produced a main effect of condition, revealing no significant difference in PRS-ch scores between boys and girls and between the two educational levels.

Environmental preference

Of all the conditions, the PT was perceived as the least appealing, followed by the MS, and the AW, which was perceived as the most appealing of the conditions (Table 1). As shown in Table 1 repeated measures ANOVA showed a significant effect of the condition on preference scores. Means comparisons showed that preference scores differed significantly for each pair of conditions compared ($p<.001$ for each of the six comparisons).

Perceived restoration and environmental preference are not overlapping constructs, and in this study this is demonstrated by the value (from medium to low) of the correlation between the two measures in the three conditions: .68 for the PT condition, .66 for the MS condition, and .26 for AW condition.

CNS-children scores

The CNS-ch devised for this study showed good reliability (Cronbach's Alpha=.84). One-way ANOVA showed no significant effect of condition. Mean scores of CNS-ch did not significantly differ among the three conditions. This means that children's perception of how much they feel connected to Nature did not depend on where they are and what they experienced before filling the scale. Also the two mixed ANOVAs with condition (three levels, i.e. PT, MS and AW) as the within-subjects factor and gender or class as the between-subjects factor, showed neither the main effect of condition and of gender/class, nor the interaction condition x gender/class. The CNS-ch scores did not differ between boys and girls and between 4th and 5th graders, and the score trend was the same in the three conditions, regardless of gender and class.

Analysis of objective physical measures

Blood pressure

Minimum and maximum blood pressure was measured in three conditions: after PT, after MS, and after the walk in the AW. As shown in Table 1, the effect of condition was significant both for the minimum and for the maximum blood pressure, even if the effect was smaller than for the PRS. The mean comparisons revealed that the only significant differences were between PT vs. the other two conditions, both for minimum (PT vs. MS: $t(45)=4.97$, $p< .001$; PT vs. AW: $t(39 =2.53$, $p<.05$) and for maximum blood pressure (PT vs. MS: $t(45)= 4.53$, $p<.001$; PT vs. AW: $t(39)=3.16$, $p< .01$). The mean values in Table 1 show that blood pressure was lower after MS and after AW than after PT.

As regards maximum blood pressure, the mixed ANOVA showed that boys' blood pressure was higher than girls' in each of the three

conditions, in fact the main effects of condition and gender were significant (condition: $F(2,76) = 10.48$, $p < .001$; gender: $F(1,38)=4.32$, $p<.05$), whereas the condition x gender interaction was not. For minimum blood pressure, neither the effect of gender, nor the condition x gender interaction emerged, but only the main effect of condition, showing that the conditions had the same effect on minimum blood pressure in males and females.

Although in this study diastolic blood pressure values differed significantly among conditions they are normal for children of that age (diastolic blood pressure: from 48-52 to 78-81) [51].

Heart rate

Heart rate was measured in the three conditions. As shown in Table 1, the main effect of the condition was significant. The comparisons revealed significant differences between PT and the other two conditions, PT vs. MS: $t(45) = 15.4$, $p < .001$, PT vs. AW: $t(45)=12.5$, $p<.001$. There was no significant difference in heart rate when measured in the MS and in the AW condition. As shown in Table 1, heart rate was slower after MS and after AW than PT.

The mixed ANOVA, with gender as the between-subjects factor and condition as the within-subjects factor, showed the main effect of condition only ($F(2,76) = 108.32$, $p<.001$), whereas the main effect of gender and the condition x gender interaction were not significant. This means that boys and girls had the same mean heart rate in all conditions.

Considering the two classes included in the ANOVA, the mean heart rate of 4th graders was lower than that of 5th graders' ($F(1,38)=9.55$, $p<.01$), though no condition x class interaction was found; this shows that the heart rate trend was the same as the one described above, with only the significant main effect of condition: $F(1,28)=151.40$, $p<.001$.

Analysis of performance

One of the main aims of this study was to verify whether mindful silence practice (MS) in a built environment, free play in a mixed environment (PT) and spending some time in a totally natural environment (AW) had any effect on cognitive performance, measured using the Continuous Performance Test. To this aim we considered two measures of the test: correct responses (CPT-score), and speed of performance (CPT-time).

CPT- scores

As shown in Table 1, CPT-scores differed significantly among the three conditions. CPT-scores were lowest in the PT condition, followed by MS, and then the AW, when children produced the greatest number of correct responses; all differences turned out to be significant based on the mean comparisons, $p<.05$ for the comparison between MS and AW, and $p<.001$ for the other comparisons.

The mixed ANOVA performed to verify the role of gender and class in this design, showed no significant main effect of gender and class, and neither the condition x gender, nor the condition x class interactions. This means that girls and boys performed at the same level, and no difference in the mean scores was found between 4th and 5th graders.

CPT-time

Table 1 shows the significant effect of condition on performance speed. An analysis of mean CPT-times revealed that children needed more time to perform the test, i.e. they were slowest, in the PT condition, whereas they were fastest in the AW condition; all these differences turned out to be significant for each pair ($p<.001$).

The mixed ANOVA, with gender as the between-subjects factor and condition as the within-subjects factor, showed the main effect of condition ($F(2,76)=106.34$, $p<.001$) and gender ($F(1,38)=4.24$, $p<.05$), with girls performing faster than boys.

The mixed ANOVA, with the two classes as between-subjects factor, shows the main effect of condition ($F(2,76)=106.35$, $p<.001$), and no differences in CPT-time between 4th and 5th graders, though the significant condition x class interaction was found ($F(2,76)=4,77$, $p < .05$). This last result is due to the fact that, even if the speed trend was the same in the two classes, i.e. PT slower than MS slower than in the AW, 4th graders were slower than 5th graders in the PT condition, while 5th graders were slower than 4th graders in the MS condition. The two groups responded at the same speed in the AW condition.

Discussion

Studies in the literature have shown that natural environments serve physiological, emotional and attentional restoration better than artificial environments [for a review 52]. According to the Attention Restoration Theory [4], restoration from attentional fatigue occurs with psychological distance from routine mental contents in conjunction with the engagement of effortless interest-driven attention. Moreover, Nature (or its reproduction) has been reported in the literature as being the principal source of restoration; positive effects can quickly appear in physiology (around 4 minutes) [28], in emotional states (after 40 minutes) [53]; (within 10-15 minutes see) [54], and in cognitive performance (less than 10 minutes) [18,55,56].

This study wanted to verify whether psychological restoration works in children in the same way as it does in adults. To this end the Perceived Restorativeness Scale-children (PRS-ch), the Connectedness to Nature Scale-children (CNS-ch) and the Continuous Performance Test (CPT) were administered to a group of primary school children in three experimental conditions: in the classroom after practicing mindful silence(MS), in the courtyard outside the school after play-time (PT), and after a walk in an alpine wood (AW). In addition to self-report (PRS-ch and CNS-ch) and performance measures (CPT) we also assessed objective physiological measures (systolic and diastolic blood pressure, and heart rate).

First of all we considered the psychometric characteristics of the PRS-ch. The scale turned out to be a reliable instrument to assess perceived restoration in children. Consistency across genders, confirmed by the lack of the main effect of gender for PRS measurement, is an important result in accordance with the PRS literature on adults [27,44-45,48]: there are no differences between males and females, whether children or adults, in perceiving and therefore in assessing the restorative value of a place. Consistency across classes is also a good result; first, 4th and 5th grade children can be considered a homogeneous sample, and second, there is no theoretical reason for any difference in the perception of restorativeness between children so close in age. Since it is unrelated to gender and class, and given the good Cronbach's alpha value, the PRS-ch turned out to be a reliable instrument with good psychometric characteristics.

The most striking result from the CNS-ch is the independence of the assessment from the experimental condition; children's feelings of

being or not being connected with Nature were not affected by the experimental condition (PT, MS, AW). Though a CNS-state exists (CNS items start simply by "right now" to tap present feelings of connectedness to the natural world) [57], the individual's affective affiliation to Nature has turn out to be a stable trait in adults [42,57]. Accordingly, the CNS-ch can be considered a sort of consistent «trait measure», in contrast with the PRS-ch that has to be a «state measure» to be reliable. In fact, we expected the assessment on the PRS-ch to vary in relation to the characteristics of the place, whereas there was no reason for the assessment on the CNS-ch to vary.

In this respect, the most striking result concerns children's perception of restorativeness, which not only differed significantly depending on the place characteristics, with the wood perceived as the most restorative, but also depends on the activity performed. In this case although the playground had more natural elements than the classroom, and in the playground children could play freely, the classroom was perceived as more restorative than the playground because of a fascinating activity taking place there [20]. In fact in the MS condition, though occurred in the classroom, children were given an opportunity to regain composure and focus without effort; basically mindful silence avoids directed mental activity and allows to achieve fascination, the core of a restorative experience [4,20], through slow, patterned movements [23]. The connection children feel with Nature is also worthy of further investigation. In particular, it would be worth examining whether connectedness to Nature, which turned out to be a stable construct among places, increases the longer the child stays in a natural place. Moreover, since the practice of mindful silence affected the perception of the restorative characteristics of a built place (the classroom) [20], similarly the possibility of this practice also affecting the feeling of connection to Nature cannot be excluded; if this is the case, children's connection to nature could benefit not only from exposure to the natural environment but also by practicing mindful silence.

In two of the three experimental conditions, namely PT and AW, the children were required to move and play. On the contrary, in the MS condition the children were required to stand still. Even so, there was no difference in the children's blood pressure between MS and AW. Although it would seem obvious that blood pressure in both open air activities (PT and AW) should differ significantly from that in the MS condition, only the so-called restorative activities (MS and AW) had an effect on lowering children's blood pressure [16,17,20]. Again, no differences emerged for heart rate between MS and AW, whereas these activities differed significantly when compared to PT. The MS and AW conditions, namely the restorative activities, had the same effect on children's heart rates. The significant difference between 4th and 5th grade children in the PT condition is more difficult to explain: after performing this activity 5th graders' heart rates were faster than 4th graders'.

It is important to highlight that in this study physiological parameters were assessed when the children were calm and not during the actual activity performed beforehand (mindful silence, playing, and walking). In sports medicine the correlation between physical effort, systolic blood pressure and heart rate is well known: physical effort results in higher systolic blood pressure and heart rate [58]. For this reason, since the three conditions were rather different from one another, in each condition physiological parameters were assessed after an interval of ten minutes at the end of each activity, in order to assess the child's parameters «at rest». This interval was particularly necessary in the PT condition where children had just finished a period of free play. In brief, in the MS and AW conditions, the children's systolic and diastolic blood pressure and heart rates were «at rest», whereas parameters in the PT condition were like those measured during a sports activity. The PT result does not come as a surprise, whereas it is surprising that the physiological parameters measured in the MS and AW conditions were not very different even though the activities and conditions themselves were.

The most striking result of this study was the children's attentional performance, which was significantly affected not only by the place where they were, but also by the activity they engaged in before the measurements were performed. It emerged quite clearly from our results that the best attentional performance, in terms of correctness and speed, was associated with the setting perceived as the most restorative, the wood; however, since the PRS-ch includes items on activities related to that place as well, we can also state that the best attentional performance was related to the restorativeness of the activity performed in that place. Our results concerning the walk in the wood were as expected, whereas we had not expected that children would perceive mindful silence more restorative than play-time; this affected their assessment of the perceived restorativeness of the classroom and in particular had a positive effect on attentional performance in that condition. This result is consistent with the assumptions of the Attention Restoration Theory [4]. According to Attention Restoration Theory, cognitive performance benefits from engaging in activities or experience environments that are hypothesized to elicit fascination; fascination is the less effortful (involuntary) form of attention and is deployed when environmental stimuli are intrinsically interesting. The engagement of fascination allows the directed attention system to recover; performance on directed attention task (CPT) is considered to be a measure of attentional recovery [18], and therefore evidence of the extent to which the activities and environments are "restorative".

In this study we were also interested in verifying whether children, like adults, prefer natural places to artificial ones. For adults, there is a large body of data demonstrating that natural environments are consistently preferred and are more restorative than urban environments [4-5,17,19,24-28,59,60], and in urban settings, scenes with vegetation tend to be preferred over those lacking this [61]. Previous studies have found that experiencing Nature significantly improves the emotional states of stressed-fatigued individuals, whereas exposure to urban scenes tends to work against emotional well-being [54]. Similarly to the perception of restorativeness, in this study children's preference for a place goes hand in hand with the activity performed in that place. As already stated in the introduction, unlike play-time in the playground, the walk in the wood was not a totally free activity. Therefore not only might the children have preferred the playground to the natural place, but it might also have turned out to be more restorative. This was not the case. Surprisingly, the children were able to assess preference for and, in particular, the restorative effect of the wood and of the playground regardless of the activity they engaged in. On the contrary, preference for and restorativeness of the classroom benefited from the restorative activity associated with the place, i.e. the practice of mindful silence.

Although this study provides initial evidence that children can discriminate between the restorative value of settings with varying degree of naturalness, and psychological restoration works in children as it does in adults, there are certain limitations. The first limitation is that the study does not provide information about children's attention prior to the study, i.e. there is no attention baseline. Second, although

our results show the inhibitory system involved in the CPT task performance benefited from the restorative experience, actually there was no cognitive load to recover from, i.e. no state of mental fatigue was experimentally induced in our children [18]. Finally, as already said in the introduction, in this study there is potential confound between settings and activities; accordingly any difference in the outcome measures may be associated with the environment, the activity or an interaction between the two. However this is an exploratory study that does not claim to explain completely how attention restoration works in children; it represents a new direction in research on restorative environments. Although further research is needed, our results are consistent with Kaplan's Attention Restoration Theory [4] and the fascination-meditation hypothesis [20].

Conclusion

From laboratory research to the field, more and more primary school teachers notice in children a progressive loss of sustained attention when attending lessons in class. According to researchers, this loss of attention is caused by the loss of contact with the natural environment, in particular with the restorative power of Nature; this phenomenon is scientifically known as «deficit of nature» [13,21]. Schools with few restorative characteristics, where there is no way of benefiting from the restorative characteristics of the natural environment, should promote the implementation of mindfulness practice specifically tailored for children, such as the mindful silence introduced in this study [22,23]. We are aware that there is no substitute for the restorative power of Nature, but the practice of Mindful Silence continues to prove useful for enhancing children's directed attention and helping them to recover from mental fatigue associated with school activity.

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