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Wooden Indoor Environments' Restorativeness

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Abstract: The sensitivity and interest toward well-being and health inside work and living environments is constantly growing. Wood is perceived as a natural material by people and its presence in a room generally induces beneficial effects on human beings. In this research, two real-sized identical wood and not-wood rooms have been built to study the psychological effects of a wooden indoor environment on attention recovery and restorativeness. After a multisensory evaluation of different kind of materials used in housing, participants were asked to evaluate the two rooms and then to perform an attention test two times, interspersed with a pause in one of the two rooms. The results show that wood samples are more appreciated than all other materials and that a wood environment induces an attentional resources' recovery. These findings bring new insights in the interaction between human beings and indoor environments. This new knowledge should be taken into account in the design or renovation of buildings by architects and builders.

Keywords: wood; attention; SART; nature

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1. Introduction

Wood is a technologically complex material, and it is used for the most varied applications, ranging from construction through furnishing up to its conversion to chemicals in biorefineries. In addition to its technological properties, it is also common for people appreciate wood for its appearance, which is linked to its surface variability, the presence of knots, its grain, and its colour [1,2], and they report sensations of pleasantness and comfort towards it [3–8]. Furthermore, because of its natural and sustainable features, people seem to prefer wood, compared to other materials, such as ceramic, stone, leather, or composites [3,9,10]. The traits that make wood preferable to other materials are also linked to the feelings experienced in presence of this material. Wood is evaluated to be warmer and more relaxing than other materials [11–15], despite the similar lighting, noise, and temperature conditions in a wood and not-wood environment [2], and its perception involves all the human senses. Demattè et al. [8] demonstrated that a wooden room is judged to be more smelling and perfumed than a plaster one, and these effects are modulated by the degree of biophilia of people involved in the experiments. Another research [16] shows that the touching of hinoki cypress (Chamaecyparis obtusa) wood induces physiological relaxation. A recent study on visual comfort and well-being [17] reveals that the use of wood coatings in indoor environments produces favourable responses compared with rooms, where only white surfaces are present. Ikei et al. [6] provided an overview related to the physiological effects of wood on humans. Ikei's review highlighted many weaknesses of the analysed studies, including the low number of survey participants, poor representation of population age, absent or limited statistical analysis, and the lack of studies that consider multiple stimuli simultaneously. He concluded that the effect of wood on stress reduction could be explained in the future through the acquisition of physiological indicators [6]. Furthermore, most of the studies on psychological and physiological interactions between wood material and human beings are not done in a real size environment. The beneficial effects experienced by people in the presence of wood material can be explained with "biophilia" [18], or the human innate tendency to focus one's interest on life and vital processes. Furthermore, wood is and is perceived as a natural material, and nature exerts a beneficial restorative action on human beings' attention (The Attention Restoration Theory—ART) [19]. Due to its naturalness, wood attracts people's attention spontaneously and effortlessly [20] contributing to people's general well-being [21]. Based on the above findings and theories, the aim of this research was to study the psychological effects of a wooden indoor environment on the attention recovery and restorativeness. To reach this goal, the study has been divided in two steps: the first one involved the selection of the most pleasant building materials; once the preferred materials have been selected, two rooms (one wood and one not-wood) have been built to allow the conduction of a real-sized experiment. The two rooms have been evaluated in terms of pleasantness and their influence on attention and its recovery. The starting hypothesis is that wood, as a function of its naturalness, could exert a positive effect on people and help to restore their intellectual performance.

2. Materials and Methods

The study has been divided into two parts. First, nine constructions materials have been evaluated. Based on the materials' evaluation results, two rooms have been built using the selected materials to assess the influence of materials on attention and its recovery.

2.1. Perception and Evaluation of the Materials Characteristics

Participants. Twenty-two participants (8 women, 14 men) with a mean age of 34 years (ranging from 25 to 48 years old) took part in the pilot study. All of them were naïve as to the purpose of the study and gave informed consent prior to participation. The test took place at the Agripolis Campus of the University of Padova (Italy).

Stimuli. Nine building materials (Figure 1) were used as the target stimuli in this study. The samples were provided by an Italian seller, and they were among the best-selling material categories at the time. The selected materials were light-colour spruce wood (Picea abies (L) H. Karst), dark-colour (coloured) spruce wood, light-colour laminate, dark-colour laminate, light-colour wood-look ceramic, dark-colour wood-look ceramic, light-colour gres ceramic, white fibre cement, and dark-colour vinyl flooring. All the materials were cut into 11 cm x 16 cm pieces that were placed inside white cardboard 11 cm $\times$ 16 cm $\times$ 2.2 cm boxes. Each box was closed by a lid that was provided with a 7 cm $\times$ 10 cm window through which the sample could be seen and touched. In order to avoid any perceivable differences in the samples' thickness, polypropylene squares were placed between the sample and the box bottom. The samples were then labelled with a 3-digit random number.

The semantic differential (SD) [22] method was chosen to obtain information about the different materials. In particular, 18 7-point bi-polar scales were used to measure the perceptual, cognitive, and emotional properties of the materials. The scales chosen were the following: complex-simple, unpleasant-pleasant, unknown-familiar, rough-smooth, hard-soft, odourless-perfumed, cold-warm, artificial-natural, dark-bright, fragile-sturdy, negative-positive, tiring-restorative, harmful-healthy, light-heavy, shiny-matt, unlike-like, noiseless-noisy, and dry-moist.

Procedure. The participant sat at a desk in front of a laptop with a 13 monitor. The PsychoPy software (Version 1.82.01, Open Science Tools, Nottingham, UK) [23,24] was used to present the instructions and collect the responses. On each trial, the experimenter placed one target on the desk and then the participant explored the target through the different senses (i.e., vision, touch, smell) without moving or lifting the box and completed the semantic differential questionnaire (SDq). Both target and SD scales order were randomized. Even though the experiment was self-paced, it never lasted for more than 20 min.

Figure 1. The nine building materials used as target stimuli to assess the perception and evaluation of building materials.

Data analysis. Data were analysed by using the SPSS software (Version 23.0., IBM Corp, Armonk, NY, USA). In order to verify how the materials were perceived, the evaluation scores of all participants relative to each scale of the SDq were compared by means of a series of univariate analysis of variance with material as factor. To avoid first type error, the significance level was set at <0.01.

2.2. Attention

Participants. Forty-eight students and staff members (24 females and 24 males, mean age = 37 years old, range 24–61 years) at the University of Padova (Italy) took part in this study. All of them were naïve as to the purpose of the experiment and provided informed consent prior to their participation. The study was conducted in accordance with the Declaration of Helsinki for experimentation with human subjects.

Stimuli

Experimental rooms. Two identical rooms (Figure 2), except for the building materials used, were built inside the university campus where the School of Agriculture and Veterinary Medicine is located. Each room, sized 341 cm (l) × 320 cm (w) × 260 cm (h—inside height), had a window, a ceiling lighting, and was furnished with one desk with chair, a floor lamp, a convector heater, and a coat rack. A French window was positioned to one side to allow access to the room. White curtains were applied to both the window and the door to grant privacy. One room (wood, W) was built entirely with wooden boards of Norway spruce (Picea abies L., Karst) and Silver fir (Abies alba Mill.). The other room (not-wood, NW) was built by applying fibre-cement flat sheets to a wooden framework and by plastering and painting both walls and ceiling. For the floor, vinyl boards (LVT) were used.

To exclude the influence of physical parameters on the perceived well-being in the two rooms temperature, humidity and luminosity were monitored with a portable weather station (TFA Dostmann 30.5031) and the tests carried out under the same environmental conditions.

Questionnaires. To make the participants pay attention to the two rooms, a questionnaire was adopted to collect information about how the rooms were perceived in terms of sensory and cognitive/affective evaluation. A version of the semantic differential questionnaire [8] with multimodal items was used to gain information about how the two environments were perceived and evaluated. The questionnaire included 21 7-point bipolar scales. The adjectives to be judged were placed at the extremes of the scales and were visual (dark-bright, heterogeneous-homogeneous, narrow-spacious, pointy-rounded, complex-simple), tactile (cold-warm, rough-smooth, hard-soft, brittle-solid), auditory (shrill-feeble, acute-muffled, noisy-silent), olfactory (fetid-smelling, stinking-perfumed), and affective/evaluative items (exciting-calming, uncomfortable-comfortable, stressful-relaxing, unknown-familiar, artificial-natural, exposed-protected, unpleasant-pleasant). Participants were asked to select a score (1–7) in between the couple of adjectives to express their evaluation of the rooms.

Experimental paradigm. Following Berto's original work [25], the sustained attention to response task (SART) paradigm [26] was used to measure and tire the participants' attentional capacity. In the SART task, a series of digits (going from 1 to 9) are rapidly presented 24 times following a random order (240 stimuli in total). The test lasts for about 5 min. The digit "3" constitutes the target while the remainders are the distractors. The stimuli appear on the screen every 1125 ms and remain visible for 250 ms. The participant has to press the keyboard's spacebar as quickly and accurately as possible every time a distractor appears, avoiding responding instead to the targets.

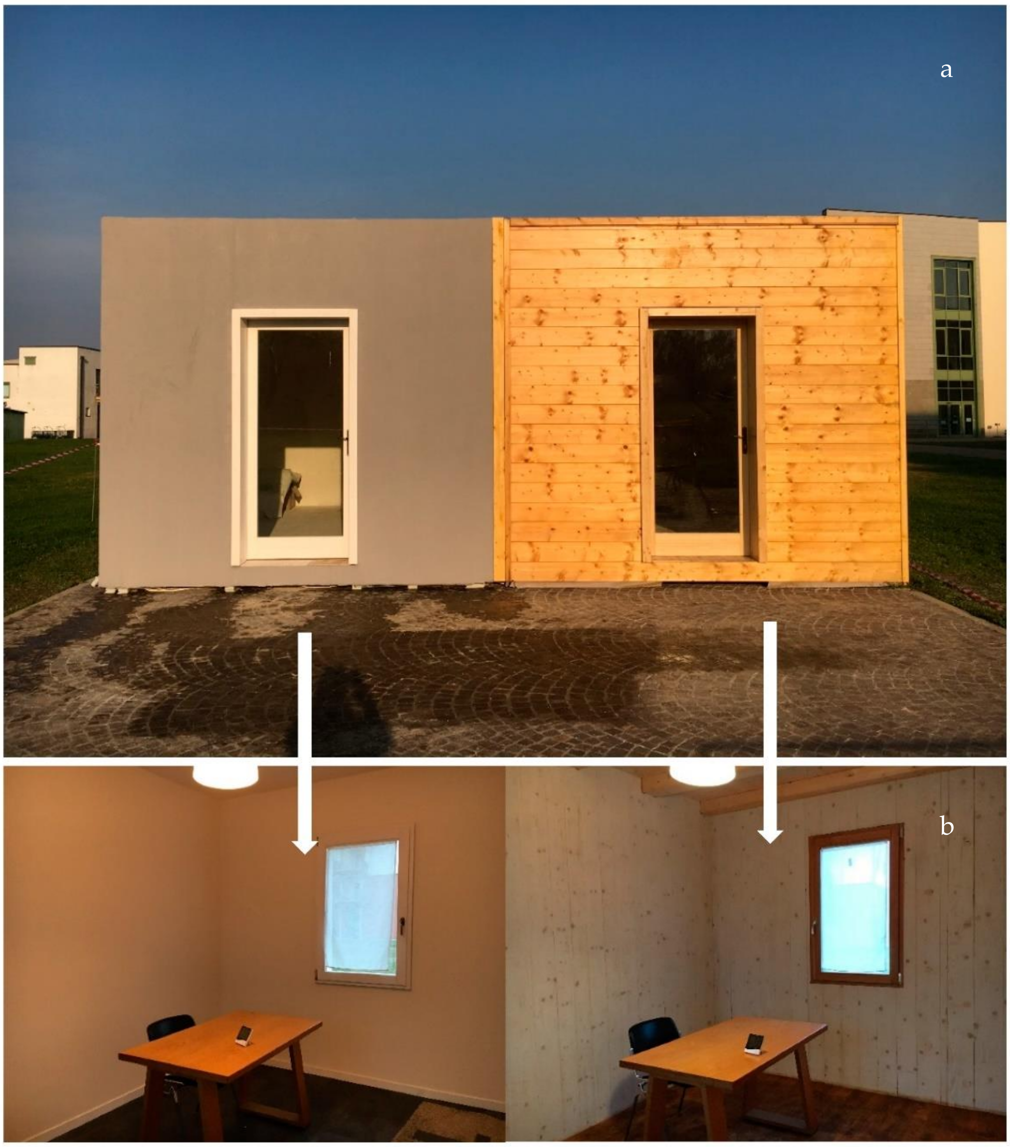

Figure 2. Outdoor (**a**) and indoor (**b**) appearance of the two building environments (left: not-wood; right: wood).

Procedure. The participants were asked to enter either the wood or the not-wood room and to sit at the desk right in front of the laptop. There, they were instructed to follow the instruction appearing on the screen and to start a short practice immediately before the experimental session started. During the practice, the series of target and distractors were presented randomly twice to allow the participants to familiarise with the task at hand. When the test had finished, the participants took a break and sat either in the wood or in the not-wood room with the sole instruction to freely take a look around the room as their evaluation about it would be collected afterwards. After the break that lasted for 8 min, the participants returned to the room (wood or not-wood) where they performed the first session of the SART test and took a second session of the SART test (Table 1). When the session was over, they were asked to evaluate both rooms by using the SD questionnaire. The session lasted for about 25 min in total. Rooms' order of presentation was counterbalanced across participants.

Table 1. Attention test experimental design (SART: sustained attention to response task; W: wood room; N: not-wood room).

Number of Participants	Group Name	Experimental Phase		
		T1: SART (Session 1)	Break (8 min)	T2: SART (Session 2)
12	WNW	Wood room	Not-wood room	Wood room
12	WWW	Wood room	Wood room	Wood room
12	NWN	Not-wood room	Wood room	Not-wood room
12	NNN	Not-wood room	Not-wood room	Not-wood room
Total 48				

Data Analysis. Each participant's number of correct responses (CR), number of incorrect responses (IR), and mean reaction time (RT) were collected. The reaction time corresponds to the answer speed. Additionally, for each volunteer the D-Prime value (DP) was computed. D-Prime represents a measure of the sensitivity of participants perception of the target throughout a testing session. These variables were then analysed by means of mixed-model analysis of variance considering groups (Wood—Not-wood—Wood "WNW", Wood—Wood—Wood "WWW"; Not-wood—Wood—Not-wood "NWN", and Not-wood—Not-wood—Not-wood "NNN") as the between-participant factor and time (T1 vs. T2) as the within-participant factor. Post hoc analysis (when appropriate) was performed by applying the Bonferroni's correction for multiple comparisons. All the analyses were performed with SPSS 20 software (IBM Corporation).

3. Results and Discussion

3.1. Perception and Evaluation of the Materials Characteristics

Table 2 shows the results of perception and evaluation of the nine materials under study. The wood samples (light and dark) were evaluated as more beneficial (6.27 and 5.95), familiar (6.68 and 6.32), healthy (6.36 and 5.91), appreciated (6.55 and 5.95), perfumed (4.68 and 5.18), pleasant (6.41 and 6.00), and restorative (6.23 and 5.82) than all other materials (light and dark ceramic, gres, fibre cement, vinyl), except for laminates. In particular, woods and laminates are valued as equally familiar, appreciated, and pleasant. Dark wood is just as beneficial, healthy and restorative as laminates. Light wood and light laminate are similarly superior to dark laminate in terms of beneficial, healthy, and restorative effect ratings. Dark wood is the most perfumed of all, while light wood and laminates look alike. Wood (light and dark) is rated as the most natural material of all. Although a limited number of participants (22) took part in this test and only nine materials were tested, these results are consistent with previous ones [3,9,13,15]. People seem to prefer wood because it is considered more natural, pleasant, warm, enjoyable, and durable than other materials, such as ceramic, stone, leather, plaster, steel or even laminated. Given the information gathered on the properties of the materials, the most and least restorative ones (light and dark real wood vs. fibre-cement and vinyl) have been used to build the two rooms where the test on the effects of the materials throughout a measurable performance have been carried out; whether the material is actually restorative, depends on if attentional resources are recovered.

Table 2. Mean description (± standard deviation) of the different samples as a function of descriptor.

DESCRIPTOR	SAMPLE					
	Wood Light Colour	Wood Dark Colour	Laminate Wood-Like Light Colour	Laminate Wood-Like Dark Colour	Ceramic Wood-Like Light Colour	Ceramic Wood-Like Dark Colour
Beneficial	6.27 (0.631)	5.95 (0.95)	5.41 (0.959)	5.09 (1.231)	4.18 (0.853)	4.27 (0.935)
Bright	6.59 (0.503)	3.32 (1.211)	5.73 (1.032)	3.09 (1.192)	5.45 (1.371)	1.91 (0.971)
Dull Sound	3.32 (1783)	3.59 (1.681)	4.00 (1.927)	3.55 (1.920)	4.91 (1.743)	5.50 (1.946)
Familiar	6.68 (0.568)	6.32 (0.945)	5.91 (1.377)	5.41 (1.501)	4.41 (1.532)	3.23 (1.378)
Healthy	6.36 (0.79)	5.91 (1.151)	5.50 (1.185)	5.09 (1.192)	4.09 (0.750)	4.00 (0.873)
Heavy	2.5 (0.859)	3.23 (1.343)	3.23 (1.020)	4.00 (1.195)	5.64 (1.002)	5.64 (1.093)
Like	6.55 (0.739)	5.95 (1.362)	5.36 (1.465)	5.14 (1.699)	3.91 (1.540)	4.18 (1.622)
Matte	3.55 (1438)	5.14 (1.699)	3.41 (1.563)	3.77 (1.631)	3.36 (1.560)	5.68 (1.427)
Natural	6.68 (0.646)	6.27 (0.827)	4.55 (2.444)	4.59 (2.261)	1.86 (1.082)	2.18 (1.622)
Perfumed	4.68 (1.862)	5.18 (1.296)	3.50 (1.683)	3.64 (1.761)	1.36 (0.902)	2.14 (1.490)
Pleasant	6.41 (0.666)	6.00 (1.195)	5.68 (0.995)	5.50 (1.185)	4.09 (1.192)	4.55 (1.224)
Restorative	6.23 (0.813)	5.82 (1.181)	5.36 (0.953)	4.82 (1.296)	3.95 (0.785)	4.23 (1.152)
Simple	5.77 (1.307)	5.27 (1.695)	4.95 (1.988)	4.73 (1.723)	3.55 (1.101)	2.95 (1.558)
Smooth	5.73 (1.486)	5.95 (0.999)	4.32 (1.524)	4.91 (1.377)	3.59 (1.469)	1.36 (0.581)
Soft	4.91 (1.925)	3.82 (1.736)	3.05 (1.495)	2.68 (1.393)	1.45 (0.671)	1.45 (0.671)
Sturdy	5.09 (1.269)	5.45 (1.143)	5.23 (1.412)	5.59 (1.141)	4.59 (1.919)	4.41 (2.085)
Warm	5.91 (1.151)	5.55 (1.335)	4.73 (1.120)	5.18 (1.368)	2.36 (1.329)	3.00 (1.380)
Wet	2.68 (1.427)	2.95 (1.362)	2.86 (1.726)	2.55 (1.503)	2.09 (1.571)	2.55 (1.738)
WEIGHT	1.95 (0.785)	2.23 (1.343)	2.68 (1.323)	3.00 (1.345)	6.45 (0.739)	6.59 (0.666)

Table 2. *Cont.*

DESCRIPTOR	Ceramic Gres Light Colour	Fibre Cement Light Colour	Vinylic Floor Dark Colour
Beneficial	3.18 (1.140)	4.05 (1.046)	3.59 (1.260)
Bright	5.45 (1.371)	6.86 (0.468)	1.36 (0.492)
Dull Sound	5.82 (1.296)	5.00 (1.718)	3.14 (2.054)
Familiar	3.41 (1.736)	3.36 (1.866)	2.00 (1.155)
Healthy	3.55 (1.405)	4.00 (0.976)	3.59 (1.221)
Heavy	5.91 (1.444)	4.00 (1.690)	3.27 (1.932)
Like	2.64 (1.620)	3.09 (1.630)	3.14 (1.833)
Matte	4.45 (2.017)	4.77 (1.602)	3.50 (1.994)
Natural	2.55 (1.792)	2.18 (1.468)	1.41 (0.796)
Perfumed	2.09 (1.377)	3.23 (1.660)	1.68 (0.995)
Pleasant	2.64 (1.399)	3.41 (1.368)	3.59 (1.563)
Restorative	2.59 (1.593)	3.45 (1.405)	3.32 (1.287)
Simple	2.59 (1.098)	3.86 (1.833)	2.41 (1.563)
Smooth	2.09 (0.868)	6.68 (0.646)	1.82 (0.958)
Soft	1.27 (0.456)	2.09 (1.306)	2.18 (1.053)
Sturdy	4.68 (1.783)	3.86 (1.885)	4.86 (1.424)
Warm	2.09 (1.377)	2.41 (1.436)	2.68 (1.323)
Wet	2.18 (1.651)	2.23 (1.602)	1.82 (1.006)
WEIGHT	5.77 (1.541)	2.41 (1.469)	2.73 (1.352)

3.2. Attention

Rooms evaluation

The scores of all participants relative to each scale of the SDq were compared by means of t-tests to understand how the wood and the not-wood rooms were perceived. The significance level was set at <0.01 to avoid first type error. Wood and not-wood room evaluations significantly differed in most comparisons, with wood room receiving the higher scores (Table 3).

The wood room was evaluated as more rounded and warmer than the not-wood one, as well as more natural and comfortable. In particular, the study by Frontczak and Wargocki [27] indicates thermal comfort as one of the most important parameters in defining the quality of an indoor environment. Therefore, at the same temperature, the presence of wood could help to perceive a room warmer than one in which wood is not present, increasing the thermal comfort feeling. Interestingly, the wood room received higher scores than the not-wood room on one of the auditory scales (i.e., muffled) and on all the olfactory scales (i.e., smelling and perfumed). These results confirm those previously found by Demattè et al. [8], where the participants experienced and evaluated either a wood or a concrete room (a single concrete environment was designed for the first test and then covered with wood for the second one), which meant the participants were unable to compare the two rooms. Moreover, in this study, to weaken any possible effects of environments comparison, half the participants performed the tests in the wood room (WNW, WWW groups) and half in the not-wood room (NWN, NNN). The same condition was applied to the break: half the participants took the break in the wood room (NWN, WWW) and the other half in the not-wood room (WNW, NNN). In the present study, the intensity of multi-sensory perception was modulated by the biophilia level of the test participants. Additionally, perceiving wood as the most natural of all the materials considered in this study could be related to the human's biophilia [18].

Table 3. Results of rooms evaluation using semantic differential questionnaire (ns: non- significant).

Evaluation	Scale	Statistics	Room
			Wood
Affective	Artificial-Natural	t(47) = 10.42, p = 0.000	6.02 ± 0.84
	Exciting-Calming	ns	5.31 ± 1.60
	Exposed-Protected	t(47) = 4.39, p = 0.000	5.58 ± 1.11
	Stressful-Relaxing	t(47) = 18.53, p = 0.000	5.71 ± 1.22
	Uncomfortable-Comfortable	t(47) = 5.67, p = 0.000	5.81 ± 0.94
	Unknown-Familiar	t(47) = 6.47, p = 0.000	5.48 ± 1.15
	Unpleasant-Pleasant	t(47) = 7.93, p = 0.000	6.10 ± 0.90
Auditory	Acute-Muffled	t(47) = 6.18, p = 0.000	5.35 ± 1.21
	Noisy-Silent	ns	5.92 ± 1.03
	Shrill-Feeble	ns	4.77 ± 1.02
Olfactory	Fetid-Smelling	t(47) = 4.74, p = 0.000	5.44 ± 1.30
	Stinking-Perfumed	t(47) = 3.74, p = 0.000	5.27 ± 1.72
Tactile	Brittle-Solid	ns	5.56 ± 0.99
	Cold-Warm	t(47) = 7.80, p = 0.000	5.65 ± 1.04
	Hard-Soft	t(47) = 9.11, p = 0.000	4.83 ± 1.33
	Rough-Smooth	t(47) = 3.81, p = 0.000	4.33 ± 1.43
Visual	Complex-Simple	ns	5.33 ± 1.58
	Dark-Bright	ns	5.27 ± 1.35
	Heterogeneous-Homogeneous	t(47) = 3.67, p = 0.001	3.98 ± 1.76
	Narrow-Spacious	ns	4.71 ± 1.22
	Pointy-Rounded	t(47) = 5.94, p = 0.000	4.23 ± 1.24

Effects on Attention

Before performing the main series of analyses to verify whether significant differences could be observed between T1 and T2 as a function of the room where the break had taken place, a first series of control analyses was conducted. The mean CR, IR, RT, and DP obtained in T1 were compared by means of a one-way ANOVA with the between-participants factor of the groups (WNW, WWW, NWN, and NNN). No significant differences between groups emerged (Table 4), suggesting that the environment where the first test (Session 1) had taken place did not significantly influence the participants' performance.

Results in Table 4 show that within the same session and considered the same variable, there are no differences between groups ($p > 0.01$), demonstrating that they all start from the same starting point. Only the sensitivity (DP) in session 2 is different between the two groups that performed SART in the not-wood room (NNN and NWN); those who paused in the wood room showed a higher sensitivity than those who paused in the not-wood one. In fact, corrected post hoc comparison with Bonferroni shows that the NNN group (M = 2.92) < NWN group (M = 3.47), $p = 0.045$ (for the other comparisons $p > 0.05$ is not significant).

Statistics in Table 4 show that there is an interaction between the session and group, in particular, there is interaction between group and session for all variables except reaction time (RT). The analyses of the effects exerted by the kind of environment where the break was taken yielded significant effects; in the case of sensitivity, corrected post hoc comparisons with Bonferroni show that only those who pause in the wood room improve their performance and not those who pause in the not-wood room (e.g., NWN S1 M = 2.98 vs. S2 M = 3.47). The same trend is found for the reaction time in correct and incorrect (errors) responses and variables; the reaction time decreases only when the break is taken in the wood room, and so the correct responses significantly increase after the break in the wood room (NWN and WWW groups), while the number of errors decrease for those who took a break in the wood room. For the WNW group, the correct responses decrease and the errors increase in those who take the test in wood and the pause in not-wood room (WNW S1 M = 2.95 vs. S2 M= 3.70). These results are consistent with the attention restoration theory (ART) [19] that states that the ability to concentrate may be restored by exposure to natural environments [28]. The mechanism of fascination or involuntary attention [20,29], exercised by wood naturalness, would induce a relaxing effect in people, contributing to their physical and mental well-being [21] and to their attentional resources' recovery [25] after a break in a room where wood is the predominant material. In accordance with the obtained results and with the Burnard and Kutnar review [30], wood seems to be a suitable material for restorative environmental design (RED) that combines sustainable and biophilic design [31].

Table 4. Mean number (± standard deviation) of sensitivity (DP), reaction times (RT), and correct and incorrect (errors) responses in Session 1 (before the break) and in Session 2 (after the break) for NNN, NWN, WNW, and WWW groups (N = not-wood room; W= wood room).

Variable	Session (S)	Group			
		NNN	NWN	WNW	WWW
DP	1	2.78 ± 0.93	2.98 ± 0.66	3.20 ± 0.61	2.94 ± 0.63
	2	2.92 ± 0.51	3.47 ± 0.51	3.08 ± 0.50	3.26 ± 0.37
Statistics	$F(3,44) = 3.29$, $p = 0.029$	ns	0.001	ns	0.032
RT (ms)	1	365 ± 62	355 ± 34	348 ± 32	360 ± 47
	2	365 ± 62	336 ± 29	351 ± 34	340 ± 32
Statistics	$F(3,44) = 2.75$, ns	ns	0.014	ns	0.008
Correct (hit)	1	14.58 ± 4.68	15.33 ± 4.10	17.67 ± 3.30	14.92 ± 3.90
	2	14.58 ± 3.87	17.92 ± 3.73	16.08 ± 3.70	16.75 ± 2.83
Statistics	$F(3,44) = 5.49$, $p = 0.003$	ns	0.002	0.054	0.027
Errors (miss)	1	9.25 ± 4.37	8.58 ± 4.06	6.17 ± 2.95	9.08 ± 3.90
	2	9.17 ± 3.71	6.00 ± 3.57	7.92 ± 3.70	7.25 ± 2.83
Statistics	$F(3,44) = 5.78$, $p = 0.002$	ns	0.002	0.035	0.028

4. Conclusions

The goal of this research was to assess the effect of a wood environment on the recovery of attentional resources using real-sized test environments. Real size test environments simulate real life conditions and a few studies on human–wood material interactions have been carried out in a 3D environment. A possible limitation of the present study could be the involvement of a limited number of participants. In order to overcome such a limitation, an accurate statistical analysis was conducted. This resulted in a validation of the obtained results, which appears to be strongly consistent with those obtained in previous studies. To demonstrate the wood restorativeness, participants were first asked to evaluate different materials using a multi-sensory approach, then to evaluate the wood and not-wood room, and finally tests on the recovery of attentional resources were conducted in wood and not-wood environments. Results show that wood is the most appreciated material. It is perceived as more beneficial, familiar, healthier, more appreciated, more perfumed, more pleasant, and more restorative than the other materials. Similarly, the wooden environment is preferred to the not-wooden one. However, the most innovative and also the main result of this study is the positive effect of a wooden environment on attention recovery. The role of a wooden environment on the recovery of attentional resources has not yet been demonstrated. Living comfort should no longer be related only to physical parameters, such as temperature, humidity, noise, or luminosity, but should also consider the psychological well-being of people that can also be achieved with the use of the right materials, such as wood. Architects, builders, and interior designers should take these results into consideration in the design of work environments, such as offices or homes.

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