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Research Paper

Forest design for mental health promotion—Using perceived sensory dimensions to elicit restorative responses

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HIGHLIGHTS

- The spatial dimensions of the environment influence the experience of restoration.
- The environment should have a balance between enclosed areas and open views.
- A natural and wild appearance of the forest with diverse vegetation is preferred.
- Memories and associations play an important role in restoration.
- The findings validate the PSDs most preferred for restoration.

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ABSTRACT

At present, research within health promoting environments is dominated by a focus on the difference between the urban and the natural environment. However, little knowledge exists regarding which qualities within the natural environment promote restoration.

The aim of the paper is to identify which qualities and perceived sensory dimensions (PSD) of a forest environment are psychologically restorative.

The research consists of 26 participants' ratings and experiences of psychological restoration in a forest environment called the Health Forest Octovia®, which consists of eight different rooms designed according to previous research on PSDs, where each room represents one of the PSDs. The participants rated the restorativeness of the rooms on a scale and they were interviewed about their experiences. The interviews were analyzed by an interpretative phenomenological analysis (IPA).

The results from the rating exercise show that the rooms where the PSDs serene, rich in species, refuge and nature are dominant are rated highest with regards to restoration, which supports the previous research on the subject. Further, the findings from the IPA indicate that the spatial aspects are important for the experience of restoration. An environment which includes diverse vegetation and balances enclosed dense growth with more open views is regarded as being optimal for restoration. The dense growth should have the appearance of a den and offer experiences of privacy.

The results validate the potential for using the PSDs as guidelines for designing health-promoting natural environments.

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1. Introduction

1.1. Health promoting natural environments

There is a growing political interest in promoting natural environments for public health as part of creating sustainable cities (European Commission, 2014; World Health Organisation, 2006). Research which supports the positive effect of interacting with

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natural environments in relation to mental and physical health promotion is also accumulating (Bratman, Hamilson & Daily, 2015; Bowler, Buyung-Ali, Knight, & Pullin, 2010; Nilsson et al., 2011). When it comes to environmental preferences with regards to stress restoration, natural environments are also, not surprisingly, preferred over built environments in a number of studies (Hartig & Staats, 2006; Staats, Kieviet, & Hartig, 2003; van den Berg, Koole, & van der Wulp, 2003).

However, not all natural environments are equally restorative (Herzog, Maguire, & Nebel, 2003) or appropriate for different users (Cooper Marcus & Sachs, 2014). But only few studies have investigated the restorative effect of different green environments or features within the environment (e.g. Grahn & Stigsdotter, 2010; Tyrväinen et al., 2014; Wang, Rodiek, Wu, Chen, & Li, 2016). At present, studies on health promoting environments are dominated by research focusing on the difference between the urban and the natural environment (Hartig & Staats, 2003; Staats, Jahncke, Herzog, & Hartig, 2016), or distance and access to natural environments (e.g. Annerstedt van den Bosch et al., 2016). Therefore, less is known about which qualities of the natural environment promote mental health.

1.2. Health-promoting forest environments

Focusing not only on natural environments, but specifically on forests is a relatively new, but growing area within the research field of health promoting natural environments (Meyer & Bürger-Arndt, 2014; Nielsen & Nilsson, 2007). An important European initiative in this area was the COST Action E39 from 2004 to 2008 (Nilsson et al., 2011), in which 25 countries participated. At present, the research field is dominated by Asian studies, which use the term "forest bathing" to refer to taking in the forest atmosphere (e.g. Park, Tsunetsugu, Kasetamni, Kagawa, & Kiyazaki, 2010). The Asian studies include a large number of forest environments, but do not distinguish between the different qualities of forests (e.g. Li et al., 2011; Park et al., 2010; Song et al., 2013). A few studies have investigated the different qualities of forest environments with regards to the influence of different managed forest types (Martens, Gutscher, & Bauer, 2011), forest stand density (An, Kim, Jeon, & Setsu, 2004) and vegetation type (Annerstedt et al., 2010).

Still there is a need to improve our understanding of the specific qualities underlying the restorative potential of forest environments and natural environments in general in order to identify and develop these environments further to eventually become a resource for health promotion.

1.3. Perceived sensory dimensions

The research studying different restorative qualities within the natural environment has its offspring in the Attention Restoration Theory (ART), which was developed by the psychologists Rachel and Steven Kaplan in the 1980s (Kaplan & Kaplan, 1989). According to ART, the capacity of an environment to facilitate the feeling of being away, extent, fascination and compatibility is crucial if restoration is to occur (ibid). Some attempts have been made since the development of the ART theory to further classify and describe experiences in natural environments (Grahn, Stigsdotter, & Berggren'Bärring, 2005; Maikov, Bill, & Sepp, 2008; Van Herzele & Wiedemann, 2003). Building on this existing research, the latest attempt to categorize sensory experiences in environments was by the landscape architects, Grahn & Stigsdotter (2010). Based on a representative sample of the Swedish population, Grahn & Stigsdotter have identified 8 different perceived sensory dimensions (PSDs) (see Fig. 1). Each sensory dimension consists of a number of variables with a different factor loading (for more information on the factors constituting the different PSDs, see Grahn & Stigsdotter, 2010). The PSDs can be used to describe differences within the same type of natural environment (Tenngart Ivarsson & Hagerhall, 2008) or different kinds of natural environments from pocket city parks to larger regional green areas (de Jong, Albin, Skärbäck, Grahn, & Björk, 2012). Grahn & Stigsdotter's research further shows that people who are in need of psychological restoration prefer natural environments that are dominated by the PSDs *serene*, which is interpreted as "a haven, almost a holy place [...]" (Grahn & Stigsdotter, 2010, p.269), *refuge*, which is interpreted as a place "where people can feel safe" (Grahn & Stigsdotter, 2010, p.268), *rich in species;* interpreted as "diverse in sensory experiences" (Grahn & Stigsdotter, 2010, p.268), and *nature*; interpreted as a "wild, free-growing, untouched room" (Grahn & Stigsdotter, 2010, p.267). The other PSDs, which are *space, culture, prospect* and *social*, are related to qualities of being active, experiencing cultural objects and other people, and they are generally rated low in relation to psychological restoration. Especially the PSD, social, is negatively related to psychological restoration by stressed individuals as it involves a space where there is social activity.

1.4. The health forest Octovia®

Based on Grahn & Stigsdotter's research on PSDs, a full-scale Health Forest has been established in an existing Arboretum in Denmark. The arboretum encompasses the largest collection of different trees and shrubs in Denmark with over 2000 different species placed in relation to their geographical origin and generic affiliation (Jensen, 1994). The Arboretum is located within the municipality of Hoersholm in the northern part of Zealand. An area of 2 ha within the arboretum has been chosen as an appropriate site for the establishment of the Health Forest based on the presence of the PSDs. Based on landscape analyses which used the PSDs as guidelines, eight different spatial settings, which are referred to as *rooms,* have been located and marked, and together they constitute the Health Forest Octovia® (see Fig. 2). Each of the rooms has been chosen based on the strong presence of one of the PSDs, and has further been re-designed to accentuate this particular sensory dimension. A 750 m trail connects the eight rooms in a circular walk. The design process has been thoroughly described and documented (Stigsdotter, Refshauge, Sidenius, & Grahn, 2014). This is the first forest environment where the eight PSDs have been analyzed and emphasized through landscape design in separate areas.

1.5. The present study

A large cross over study using mixed methods was conducted in the health forest Octovia® and an urban setting during 2014-15, the aim of which was to gain deeper understanding of the restorative potential of both the forest and the urban environment in relation to both psychological and physiological restoration. The present qualitative study is part of the larger research project and focuses on participants' experiences in relation to psychological restoration in the forest environment. Psychological restoration can improve mental health by providing relief from stress (Van den Berg et al., 2003), defined as a state of physiological mobilization of energy and psychological tenseness and discomfort (Danish National Institute of Public Health, 2007).

The questions which guide the present research are as follows:

- How do the participants rank and experience the eight different rooms in the Health Forest Octovia® with regards to promoting psychological restoration?
- Which nature qualities and spatial aspects in the Health Forest promote psychological restoration?

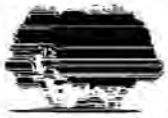
Nr.	PSD name	Images	Key nature qualities and features
1	Social		• Possible to watch entertainments • Possible to watch exhibitions • Possible to visit a restaurant or a simpler open-air restaurant
2	Prospect		• Plane and well-cut grass surfaces • Vistas over the surroundings • Cut lawns
3	Rich in species		• Several animals, like birds, insects, ect. • Natural plant and animal populations • Many native plants to study
4	Serene		• Silent and calm • No bikes • It is possible not to come into contact with too many people
5	Culture		• Decorated with fountains • Decorated with statues • A wide range of foreign plants, ornamental plants and kitchen plants
6	Space		• Spacious and free • Possible to find areas not crossed by roads and paths • Lots of trees
7	Nature		• Nature like • Wild and untouched • Free growing lawns
8	Refuge		• Many bushes • Kept animals that children and adults may feed and pet • Sandpits

Fig. 1. Names, visualizations and short descriptions of the eight perceived sensory dimensions (PSD).

2. Method

2.1. Data collection

The 26 participants included in the present study were selected from 48 female university students in Denmark, who were participating in the larger Health Forest Project. The students were recruited through posters and notice boards. Exclusion criteria were expert knowledge within the research field, drug abuse, and/or mental illness. The study was performed under the regulations of the Danish Committee on Health Research Ethics. The participants were fully informed of the aims and procedures of the study, and their written consent was obtained before initiating the research. It was chosen to recruit only female participants, to balance the research in the area according to gender, since the previous mentioned Asian forest studies only used male university students.

Half of the data collection took place in the autumn of 2014 while the second half took place in the spring of 2015, hereby taking the possible influence of seasonal change into account. The participants in the larger Health Forest Study were divided into groups of 4–5 individuals, when each group visited the Health Forest, half of the group also participated in the present study. The groups met at the university facility and were then driven to the forest environment. The participants were not allowed to talk or consume their own food or drinks during the experiment. They were offered some juice and snack at the office before driving to the environment and after the guided walk.

Upon arrival at the forest environment, the participants were seated in comfortable chairs next to the car at the entrance to the area, where they rested for 5 min, before being given a fifteen minute guided walk along the trail that links the eight rooms in the forest, during which they spent a few minutes in each room. Before starting the walk the participants were informed that the aim of the study was to identify which qualities of the forest environment they perceived as restorative and preferred in regard to finding stress relief. The participants were not informed about the design intentions of the rooms during the walk, but the guide explained where the rooms started and ended, and pointed out specific interesting botanical or cultural features of the rooms. After the walk, the participants sat down and rested for another five minutes, after

Fig. 2. The 8 rooms within the health forest Octovia®. The borders of the health forest is marked with red dots and the different rooms are marked with red outline. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

which half of the group, who were participating in the present study took part in an individual walk & talk with an interviewer, during which they visited the 8 forest rooms once again. When entering each room, the participants rated its psychological restorativeness in regard to providing stress relief on a scale from 0 to 9, where 9 represented the highest positive rating (perceived as the optimum restorativeness) and 0 the lowest rating (perceived as not restorative at all). The rating was given as an oral response to the interview question: "From a scale from 0 to 9, where 9 represents feeling completely relieved from stress and 0 represents no feelings of stress relief, how do you perceive your possibility to find stress relief in this room?"

The interview itself was semi-structured and was based on five open-ended questions about the participant's experiences, preferences, aversions and suggestions for design changes (see Appendix A for Interview Guide). The same questions were repeated in each of the eight rooms sometimes with rephrasing of the questions. If the participants gave very short answers they were encouraged to elaborate on the answers by the interviewer. Several different interviewers, all of whom had been instructed on how to use the open-ended questions, performed the interviews. The interviews took from between 21 min to 46 min. The interviews were recorded on sound recorders and later transcripted.

2.2. Analysis

2.2.1. Rating restorative experience

The participants' ratings of the restorativeness of the different rooms on a scale from 0 to 9 was summed up, and the mean value and standard deviation for each room was calculated in order to determine which mean values there were most agreement about. Further, the mean rank was calculated in order to rank the rooms, and a non-parametric Kruskal-Wallis test was performed to determine statistical difference in the ranking of the rooms from the null hypothesis (no statistical difference in the ranking).

2.2.2. Interpretative phenomenological analysis

An interpretative phenomenological approach was chosen to analyze the interviews to gain insight into individual experiences as well to establish recurrent themes. The interpretative phenomenological analysis (IPA) is theoretically rooted in phenomenology and hermeneutics and its strength lies in its capacity to identify meaning-making in peoples' lived experiences within specific contexts (Smith, Flowers and Larkin, 2009), in this case experiences of psychological restoration in the eight different rooms. Since it is assumed that several people can have certain experiences in common, the IPA analysis further facilitates an analysis of the individual experiences in a shared perspective, thereby constructing ordinate and recurrent themes across experiences (Smith et al., 2009).

Each participant in each room formed a separate case, and these were analyzed to capture the participant's original experience of the room through identifying emergent themes. These initial analyses led to the formation of a key emergent theme for each participant in each room (see Fig. 3). The key emergent themes then formed the basis for establishing shared ordinate themes across cases for each room by searching for connections between the individual key emergent themes through abstraction, subordination and integration (Finlay, 2011). The term ordinate theme can be seen as an overarching umbrella term for a cluster of key emergent themes. In this step of the process, the focus moved from the individual to the shared perspective. Further, special attention was given to unique themes where individual experiences were not shared by the group in order to avoid losing any important idiosyncratic dimensions of the findings (Finlay, 2011).

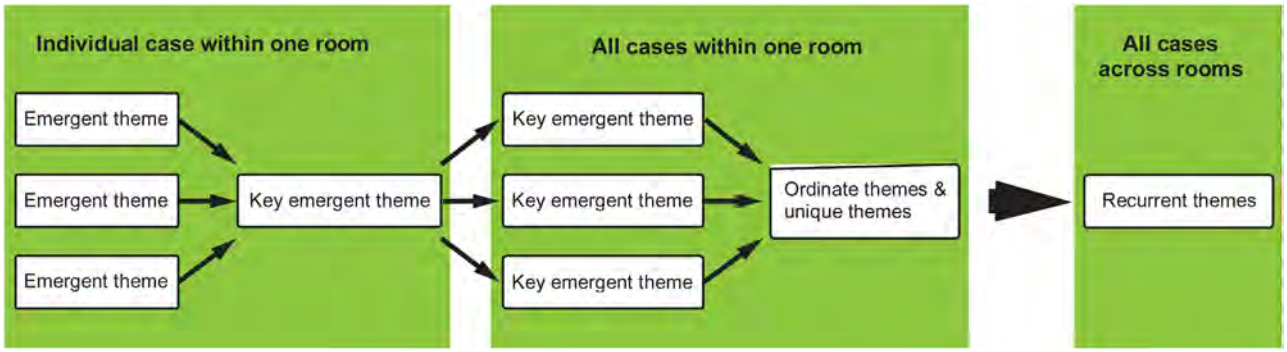


Fig. 3. The process of the IPA from the individual case to all cases.

The material was then re-analyzed in order to identify recurrent themes in the data, which took the form of recurring narratives in the participants' experiences (Finlay, 2011). See Fig. 3 for an illustration of the analytical process. As a rule of thumb, a theme should be present in at least a third to half of the interviews in order to be classified as recurrent (Smith et al., 2009).

Establishing the emergent, ordinate and recurrent themes was the result of a collaborative effort between the researchers in the team at the health forest project in order to facilitate a deeper exploration of the data that would have been possible from an individual perspective. The analytic process took place as a spiral-like process, where the individual steps in the analysis where continuously audited in close dialogue with the data.

3. Results

3.1. Rating restorative experiences

The findings from the rating exercise are presented in Table 1, which shows that room 4 with the PSD *serene* was rated as the most restorative room, followed by room 3 with the PSD *rich in species*, room 7 with the PSD *nature* and room 8 with the PSD *refuge*. The rooms rated less restorative were; room 2 representing the PSD *prospect*, followed by room 1, *social*, room 6, *space*, and finally room 5, *culture*, which was rated as the least restorative room of the eight. The smallest standard deviation is found for room 1, signifying that there was close accordance between the participants in the rating of this room. Overall, the data show low stand deviations, signifying that there was general agreement on the perceived restorativeness of the different rooms. The results from the Kruskal-Wallis test showed significant difference the ranking of the rooms ($H = 63.48$, $d.f. = 7$, $p < 0.001$).

3.2. Ordinate themes

In IPA, the presentation of the findings is seen as "an unfolding evidence trail" (Finlay, 2011; p.142) and the results are commonly presented with quotations from the participants in order to make the evidential base of the findings more transparent (Smith et al., 2009). This approach is, therefore, also implemented when presenting the results below. The presentation of the results focuses on the ordinate and recurrent themes, as these provide the level of perspective appropriate for this study; key emergent themes from individual participants are summarized briefly to illustrate their contribution to the ordinate themes. (See Table 2 for an overview of the rooms, their ordinate themes and PSD).

3.3. Room 1: open and constructed

Room 1 represents the PSD *social*, which is interpreted as a place prepared for entertainment (Grahn & Stigsdotter, 2010, p.268) (See Fig. 4 for site plan and picture of room 1).

According to the IPA analysis, the ordinate theme for room 1 is *open and constructed*, based on the participants' key emergent themes, which were: still standing, open, public, bare, human touch, arrival point, rest area, practical room, spectator-like, open, open, cozy, passing through, spacious, open, artificial, bare, undefined borders, left to itself, open, open, cozy and open.

Generally, the participants experienced the room as being too open with not enough sheltering vegetation. It was viewed as being too artificial in the way the benches were ordered in a row with piles of wood behind them, and insufficiently private due to the path and meeting point in front of the benches, "It has a rather man-made feeling" (Participant no.103). The room was associated with a meeting point, "The room feels very public" (Participant no.006). The participants requested more trees and bushes to create a feeling of safety, but also to provide sensory stimulation, and a gathering feature for the room such as a fireplace. The negative evaluation was not linked to the room itself, but was linked to the desire to seek restoration from stress. Several participants confirmed that if they were looking for social activities, the room would be very suiTable Some participants found the room cozy, mostly due to memories related to places with bonfires and scout camps. Negative associations were related to the use of gravel for the path, which was linked to graveyards.

The participants' experiences of the room as a meeting place and ordinate theme for the room as being "open and constructed" correspond very well with the dominant PSD of the room as a *social* place for entertainment (see Fig. 1 for its key qualities and features), which, according to the present findings (see Table 1), and Grahn & Stigsdotter's research (2010), has a quite low rating concerning restoration.

3.4. Room 2: activity and space

Room 2 represents the PSD *prospect*, which is interpreted as being an open space where "it is possible to have a prospect, vistas over the surroundings" (Grahn & Stigsdotter, 2010, p.268) (See Fig. 5 for site plan and picture of room 2).

According to the IPA analysis, the ordinate theme for room 2 is *activity and space*, based on the participants' key emergent themes, which were: joyful, openness, controlled, bare, view, freedom and air, artificial, openness, horizon, space, uplifting, highway like, park, horizon, tranquility, park, space, freedom, safe, freedom, far reaching, sore eyed, cozy and cozy.

Like room 1, room 2 was perceived as open, but with a different quality of openness, "I like it being so big and you have a view,

Table 1
Ranking of the 8 forest rooms according to restorative experience.

	Room							
	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8
	PSD							
	Social	Prospect	Rich in species	Serene	Culture	Space	Nature	Refuge
Mean	6.48	6.88	7.56	8.65	5.36	6.23	6.98	7.08
SD	1.34	1.33	1.36	0.56	1.97	1.87	1.91	1.32
Mean rank	81.52	97.62	124.38	170.92	55.96	81.38	107.79	104.21
Ranking	6	5	2	1	8	7	4	3

Note: The mean value, standard deviation and mean rank was calculated for each room (number of participants answering the rating exercise: n = 26 for room 4–8, n = 25 for room 1–3). A Rank has been awarded to each room based on the succession in the mean ranks.

[. . .] you feel an urge to move further into the room" (Participant no.010). Here the openness is towards the horizon and this spatial aspect provided a feeling of freedom, which was evaluated as a positive quality, "It gives a sense of freedom and air, you feel you can really breathe here" (Participant no.111).

The room has a more enclosed area around the bench which is created by a large beech tree, which enhances the feeling of safety and balances the open quality in the view, "It's idyllic to stand under the giant beech tree with big leaves and look at the sky, it gives an amazing feeling of peace" (participant no.103).

The participants did not consider it to be an ideal room for restoration, but related it more to being active due to the large well-kept lawn. Some of the participants evaluated the lawn negatively associating it with a large road due to its rectangular and longitudinal shape. The participants contrasted the appearance of the well-kept lawn with the wildness and natural appearance of a meadow, which was preferred in relation to restoration, "I like something that is true nature, to feel nature's forces in it" (Participant no.004).

Again, the participants' experiences of space and activity correspond well with the dominant PSD as having *prospect* over the surroundings, which, like in room 1, was not rated very highly by the participants in regard to psychological restoration (see Table 1).

3.5. Room 3: enclosed, tranquil and wild

Room 3 represents the PSD *rich in species*, which is interpreted as "being diverse in sensory experiences" (Grahn & Stigsdotter, 2010, p.268) (See Fig. 6 for site plan and picture of room 3).

According to the IPA analysis, the ordinate theme for room 3 is *enclosed, tranquil and wild*, based on the participants' key emergent themes, which were: sheltered, secret, messy, natural, wild, den, adventure, protected, friendly, open den, oasis, cozy, forest like, unspoiled, private room, separate, wild, cozy, tranquility, enclosed, a passage, atmospheric, forest and lovely.

The participants experienced the room as an enclosed, wild and tranquil den. It was also experienced as having an open vertical quality directed towards the sky with a clearing in the middle. This is a new dimension of openness, whereas the openness in room 1 and 2 was related to the horizontal dimensions of the room. According to the participants, the experience of privacy was emphasized by the fact that the main trail does'nt go through the room, "You come into a little secret, a hideaway" (Participant no.007). Several of the participants commented positively on the diverse, lush and colorful vegetation, "There is a good variation of things to look at, trees and a little pond, yes, big trees, small trees, strange trees and flowers" (Participant no.100). The arching trees at the entrance were experienced as an embracing welcome by several of the participants. The circular shape of the room was evaluated as enhancing its protective and restorative atmosphere, "Not having edges, then you don't have to look around the corner, you can look the whole way around, and not worry if anybody is coming because you can see it in the distance, so you can't be frightened, but can relax more" (Participant no.108). Several of the participants contrasted the natural and organic features of the room with what they considered to be the artificial and man-made features of, e.g. room 1, "I like how it is natural not man-made. It provides a feeling of safety and comfort" (Participant no.007). Some of the participants evaluated the room as being too enclosed, which gave them a feeling of insecurity as a result of a lack of overview. The room also includes a small pond, which received negative comments from the participants in the autumn, in general, due to its artificial appearance, but

Table 2
Overview of the 8 rooms including the dominant PSD and ordinate theme for each room.

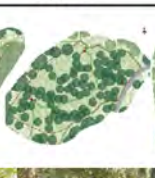
	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	Room 7	Room 8
Illustration								
Picture								
PSD	Social	Prospect	Rich in species	Serene	Culture	Space	Nature	Refuge
Ordinate theme	Open and constructed	Activity and space	Enclosed, tranquil and wild	Private, inviting and natural	Forest passage	Open, natural forest	Quietness and stability	Secret and fascinating & orderly and varied

Fig. 4. Site plan and picture of room 1, representing the PSD social.

positively by participants in the spring when the vegetation around the pond gave it a more natural appearance.

The participants' experience of diversity in the room goes well with the dominant PSD of the room being *rich in species*. The PSD description (see Fig. 1) does not entail a guideline for its spatial design, although the enclosed character of the room seems to play an important role in the participants' experience of its restorative qualities.

3.6. Room 4: private, inviting and natural

Room 4 represents the PSD *serene*, which is interpreted as a "retreat, haven, almost a holy place where you feel safe" (Grahn & Stigsdotter, 2010, p.268–69) (See Fig. 7 for site plan and picture of room 4).

According to the IPA analysis, the ordinate theme for room 4 is *private, inviting and natural* based on the participants' key emergent themes, which were: den, relaxing, view, hideaway, diverse, enchanting, wild, open and light, horizon, enchanted, private and open, nature, trance, beautiful, breathtaking, picturesque, harmonic, enclosed, boring, appealing, natural, calming, attractive, variation, nice, dynamic and calm.

Apart from one participant, there was overall agreement that room 4 was the most restorative room in the health forest (see Table 1), which corresponds well with the fact that this PSD is

Fig. 5. Site plan and picture of room 2, representing the PSD prospect.

Fig. 6. Site plan and picture of room 3, representing the PSD rich in species.

Fig. 7. Site plan and picture of room 4, representing the PSD serene.

the most preferred sensory dimension in natural environments, regardless of stress level, according to Grahn & Stigsdotter (2010).

The feeling of being private due to the dense vegetation, but at the same time not closed in due to the open view was seen as a key feature for restoration, "You are protected by the forest behind you, and have the openness in front of you, that is really appealing" (Participant no.011). The private path leading to the bench area was also viewed as a positive feature that enhanced restoration due to its enclosed structure, "You feel like you are walking through a den to come out to something grand and beautiful" (Participant no.108). Most of the participants mentioned the presence of water as being important for the restorative experience, but also a diversity of sensory experiences with both audio and visual experiences being important. Several stated that they could remain in the room for a long time and be absorbed by the sensory inputs, "It is a place where you can let your thoughts wander" (Participant no.023).

One participant differed significantly from the group regarding her experience as she described the room as boring, which she attributed to the still lake surface and the absence of opportunities to view other people. She defined herself as a city person with a preference for being around other people.

The participants' evaluation of the room as a private and natural retreat corresponds well with its *serene* PSD, interpreted as a haven. Again, the PSD description (see Fig. 1) provides no guidelines for the spatial design related to this sensory dimension, which seems to be very important for the participants' experiences of restoration in the room.

3.7. Room 5: forest passage

Room 5 represents the PSD *culture*, which is interpreted as containing a "core of human culture" like "fountains, statues, exotic plants, ponds, etc." (Grahn & Stigsdotter, 2010: p.268) (See Fig. 8 for site plan and picture of room 5).

According to the IPA analysis, the ordinate theme for room 5 is *forest passage* based on the participants' key emergent themes, which were: forest like, memories, indifferent, passing through, passage, playroom, undefined, nice, fun, path, passage, gravity, random, forest, path, disturbing, cozy, forest, dark and messy, boring, undefined borders, passage, passage, cozy, boring and den.

In general, the room was experienced more as a common forest passage than a room as such, which was evaluated negatively with regards to restoration, "It seems like a place you walk through, maybe you'd sit down for a short break, but it is not a place you walk to. It seems more like a passage" (Participant nr.007). The room was also not considered to be private enough due to the placement of the benches next to the path. One participant, the same one who did not consider room 4 to be very restorative, was not put off by the passage-like appearance of the site. She pointed out that she liked the fact that other people may pass by.

The historic feature of a rampart was perceived as adding an interesting dimension to the room, but was not related to restoration. Just outside the room, there was a store of building materials, which belonged to the arboretum. All the participants thought that having these man-made and untidily-placed objects within eyesight was very disruptive for the restorative experience, "The illusion that the forest is endless is not sustained here" (participant no.011).

The PSD *culture* is represented in the room by a particular ash tree which dates back to 1934 and the historic rampart, which was used as a path for people and their livestock in the past. However, as several of the participants pointed out, the rampart and ash tree are very subtle cultural features, which they would not have thought about, if they had not been told about their significance by the interviewer on the initial group walk. Initially, when analyzing the room, the presence of the PSD *culture* was also weak, but due to restrictions at the arboretum, it was only possible to restore the rampart and, therefore, the room is not a strong representation of this PSD. The ordinate theme being a forest passage also does not correspond well with the intended PSD as containing a core of human culture.

The room was rated lowest with regards to restoration (see Table 1), but this is also not the intention of the PSD *culture*; according to Grahn & Stigsdotter's research (2010), people seek this kind of environment due to its cultural, not restorative, qualities. Therefore, this PSD is expected to have the least natural appearance.

3.8. Room 6: open natural forest

Room 6 represents the PSD *space*, which is interpreted as a "spacious and free environment", "with a quality of connectedness" (Grahn & Stigsdotter, 2010, p.268) (See Fig. 9 for site plan and picture of room 6).

According to the IPA analysis, the ordinate theme for room 6 is *open natural forest* based on the participants' key emergent themes, which were: non-private, nice and boring, homey, passage, forest feeling, open, natural forest, open and light, open passage, natural forest path, untouched forest, untidy and disturbing, natural forest, nice view, neutral and uninteresting, cozy, neutral forest, dense vegetation, variation, homogeneous, in the forest, cozy, green, boring, enclosed, boring and not private.

The room has the appearance of a natural forest, which was positively received, "It's very pleasant, very standard forest-like, I don't think there is anything extraordinary about it, just very natural" (Participant no.100). It was not considered an optimal room for restoration due to the lack of fascinating features as well as a lack of privacy, "There is not much fascinating about it. It is just small trees and not much else" (Participant no.005). Overall, the participants demanded more vegetation and privacy in order to gain a restorative benefit from being in the room. Some of the participants made strong associations with forest walks in their home environment, which gave a higher evaluation of the restorative experience.

The use of chipped bark on the path was largely perceived as positive with regards to providing an interesting sensory experience when walking on, for some it conjured up memories of, e.g. being at kindergarten. However, some also found it intrusive due to its artificial appearance, which they thought did not belong in a forest.

The participants' evaluation of the room as a natural forest is in accordance with the dominant PSD of the room representing a spacious and free natural environment (see Fig. 1). It was not, however, highly valued with regards to restoration (Table 1), and the participants had a quite indifference experience of the room. The PSD of the room was also intended to enforce a feeling of connectedness, which the participants did not mention.

3.9. Room 7: quietness and stability

Room 7 represents the PSD *nature*, which is interpreted as experiencing "the inherent force and power of nature, its dynamic and intrinsic vitality" (Grahn & Stigsdotter, 2010, p.267) (See Fig. 10 for site plan and picture of room 7).

According to the IPA analysis, the ordinate theme for room 7 is *quietness and stability* based on the participants' key emergent themes, which were: protected, cozy, den, open and closed, still standing, calm, magical, den, protected, cozy and protected, wild, deserted and gloomy, nice and dark, sad and dark, natural, den, private, open, fairytale-like, troll like, gravity, lovely memories, stability and quietness, atmospheric, winter-like, embracing.

The room is dominated by large pine trees, which were perceived as providing protection and stability, while giving the room a magical atmosphere by the majority of the participants, "It sets the stage for reflection, higher or deeper thoughts because of the effect of the large, tall trees, I think it is a magnificent room" (Participant nr.024). However, some participants also associated the pines with darkness, insecurity and even death due to their unchanging and dark appearance, "It seems deserted and gloomy; pine trees, I have never liked pine trees. I always get the feeling that it's a bit sinister" (Participant no.100). The large, tall pines gave an overall feeling of being small, but there was disagreement as to whether this enhanced or countered the restorative experience. The participants who reacted positively to the pines generally had positive memories related to pine trees.

Several participants commented on the dual open and enclosed quality of the room due to the large trees (enclosed) with spread branches (open). The dominant smell of pine and the fact that the forest floor was covered with moss and pine needles was seen as positive.

All the participants were, in one way or another, affected by the size and appearance of the pines, which corresponds well with the dominant PSD *nature*, representing the inherent force and power of nature. However, with regards to restoration, the evaluations of this particular quality were somewhat contradictory, although mainly positive.

3.10. Room 8: secret and fascinating & orderly and varied

Room 8 represents the PSD *refuge*, which is interpreted as a place where "people can feel safe, play or simply watch other people being active" (Grahn & Stigsdotter, 2010, p.268)

Fig. 8. Site plan and picture of room 5, representing the PSD culture.

Most participants had two separate experiences of Room 8; one was related to the area around a weeping beech tree, while the other was connected to the overall room. The ordinate theme also reflects this division in that *secret and fascinating* relates to the weeping beech, while *orderly and varied* relates to the rest of the room.

According to the IPA analysis, participants' key emergent themes for the majority of the room were: too ordered and garden-like, man-made passage, open and protected, boring, orderly and controlled, lush, orderly, open, man-made lovely, oasis and calm, varied, cozy and exciting, incoherent, nice and open, safe and homey, constructed, cozy garden, nice change, opens up, garden-like, structured and diverse, too empty, light and closed.

The key emergent themes for the area around the weeping beech were: fascinating, wild, natural, wild, protective, fairytale-like, cozy, closed and den-like, secret den, den, cozy, fascinating and diverse (Fig. 11).

The majority of the room was experienced as a bit too man-made and orderly, mostly due to the plant beds," "I think it is quite boring and very ordinary; it's just very garden-like" (Participant no.004). But several of the participants still thought the room had restorative qualities due to its diverse and sheltering vegetation behind the benches, "I feel protected even though it is open, it doesn't feel as open as the first room, maybe it is because of the tree" (Participant no.007). The area around the weeping beech was overall experienced as a cozy secret den, "You enter a secret den, and you have your own private room in the middle of the forest" (Partici-

Fig. 9. Site plan and picture of room 6, representing the PSD space.

Fig. 10. Site plan and picture of room 7, representing the PSD nature.

pant no.010). Apart from the area around the weeping beech, the room was not rated very highly with regards to restoration, mainly because it lacked interesting features, "There isn't a horizon that I can be taken in by, I don't really know what I am supposed to do here, if I was alone I would walk on" (Participant no.022). The participants who related most positively to the room associated it with memories of being in other gardens.

Based on the characteristics of the PSD *refuge* (see Fig. 1) as a room where people can feel safe and watch other people being active, the room was intentionally designed to have two different areas; the area around the weeping beech was intended to appeal more to children, while the remainder of the space was intended to be a resting place for adults. The findings reveal that the weeping beech was also very appealing to adults and was considered to have more restorative qualities than the rest of the room. The ordinate theme for this part of the room was *secret and fascinating* which also corresponds better with the dominant PSD *refuge* than the ordinate theme for the majority of the room which was *orderly and varied*.

3.11. Recurrent themes

3.11.1. Recurrent theme 1: the open versus the enclosed

In the participants' narratives of their experiences, they often juxtaposed qualities in order to describe a specific quality of a room. Descriptions of *openness* and *enclosedness* were repeatedly mentioned throughout the interviews, and often in conjunction with or juxtaposing each other. In total, 21 of the 26 interviews included descriptions of *openness*, whereas 17 of the interviews

Fig. 11. Site plan and picture of room 8, representing the PSD refuge.

entailed descriptions of *enclosedness*. Based on this general high frequency of the two qualities, *open versus enclosed* is seen as a recurrent theme, "It is a funny combination, of being open, and yet again enclosed" (participant nr.121, room 5). In room 1, the openness of the room itself was evaluated negatively, whereas the open view in room 2 was positively evaluated because it was possible to see the horizon, while the room also provided a more enclosed area. According to the participants, room 4, which was rated as the most restorative room, had a good balance between open and enclosed as sheltering vegetation was present at the back, which was balanced by an open view, "You are protected by the forest behind you, and have the openness in front of you, that is really appealing" (Participant no.011). According to the participants, it was important that the openness provided an overview with interesting sensory experiences. The enclosed quality should provide a feeling of safety. However, the spaces should not be too enclosed, which is how some participants experienced room 3.

3.11.2. Recurrent theme 2: natural versus manmade

The participants contrasted *natural* with *manmade* or constructed in relation to the qualities of the various rooms, "I feel that I need something natural to look at to be able to really relax, something that can't be controlled" (Participant no. 108). In 16 of the 26 interviews, the participants mentioned *natural* or *nature-like*, whereas 11 of the interviews mention of *artificial* or *manmade*. Natural versus manmade is, therefore, also regarded a recurrent theme.

The elements which the participants experienced as manmade were generally rated negatively as they did not belong to the forest environment, e.g. the well-kept lawn in room 2, the pile of wood in room 1, the gravel on parts of the path connecting the rooms, and the pond in room 3 when the vegetation around it was still young. In general, a natural appearance was regarded as being positive and was considered to promote restoration, "I like how it has the appearance of untouched wild nature; that it hasn't been manipulated" (participant no.024).

3.11.3. Recurrent theme 3: the den

When the participants described why a room gave them a feeling of comfort and safety, they often referred to it as a den; the word den is used 60 times in total in the interviews and descriptions of the room as a den was present in 17 of the 26 interviews. Therefore, *the den* is also regarded as a recurrent theme. The participants used the word den to describe an enclosed space which provided them with a feeling of privacy and security, which enhanced relaxation, "You can sit and relax in your own little private den here" (participant no.010, room 3). The vegetation in the room played an important role with regards to creating the experience of a den. Rooms 3, 4, 7 and 8 were all described as having den-like features. In room 3, the surrounding small trees with the opening in the middle created the den, whereas it was the tall pines in room 7. In room 8, the area underneath the weeping beech created an enclosed space, which was experienced as a den; "It has the resemblance of a secret den you want to explore" (participant no.100, room 8). In room 4, the protecting vegetation behind the bench and the enclosed entranceway gave an experience of a safe den, "It's like you are entering a little safe den, a room all on its own" (participant no. 004, room 4).

3.11.4. Recurrent theme 4: memories of nature experiences

Another factor which influenced the participants' experiences of restoration was memories related to previous experiences in the same kind of environment such as camping vacations, forests back home, or grandparents' gardens. This is the case in 17 out of the 26 interviews. Therefore, memories of nature experiences are also seen as a recurrent theme,

> "This room (room 7) is also one of my favorite rooms [...] because it reminds me of being on vacation in Sweden, the Swedish pine forests (Participant no.004). The memories usually had strong emotional ties and, therefore, had a significant influence on how the room was experienced, 'This is like a beech forest; I like that because it reminds me of where I grew up' (Participant no.117).

Table 3
Frequency of recurrent themes used to describe a quality within one of the 8 room.

	Open	Enclosed	Natural	Manmade	Nest	Memories
Room 1	17	1	0	4	0	5
Room 2	17	3	2	2	0	7
Room 3	6	8	6	3	10	1
Room 4	10	4	4	0	7	5
Room 5	1	1	0	0	4	4
Room 6	4	2	5	0	4	4
Room 7	9	10	5	0	8	7
Room 8	8	8	6	2	10	1

Note: The rooms rated the most restorative according to Table 1 is marked with grey in the table.

3.12. Overview of frequency of recurrent themes

Table 3 gives an overview of the number of times a recurrent theme is mentioned within the different rooms to describe a quality of the room. If the theme is mentioned as a juxtapose to a quality in the room or as a reference to a missing quality, it is not included in the table.

Table 3 shows that the rooms which have the highest rating for restorativeness according to Table 1 (rooms 3, 4, 7 and 8) are also the rooms where the recurrent theme *den* was mentioned most frequently as a quality in the room. The themes *enclosed* and *natural* also have a large representation in those four rooms. When it comes to the theme *open*, the rooms that were regarded as the least restorative (rooms 1, 2, 5 and 6) either have the highest reference to open or the lowest. No pattern is found in relation to the themes *man-made* or *memories*.

4. Discussion

4.1. The spatial and physical qualities

According to the results, the experience of both openness and enclosure in a forest room are important for psychological restoration. Openness should provide an overview, while enclosure should provide a feeling of safety. These findings are in line with Roger Ulrich's psycho-evolutionary theory, which is related to our evolutionary past as hunters and gathers in open savanna landscapes (Ulrich, 1993). The theory emphasizes people's evolutionary preference for a secluded resting place with overview to ensure survival (Ulrich, 1993), which is often illustrated by a lone tree on the savannah.

The participants' frequent use of the word 'den' to describe the enclosed restorative quality in the environment is in accordance with Jay Appleton's prospect-refuge theory, which emphasizes that for a place to feel safe, it should have the character of an enclosed refuge with an outlook (Appleton, 1975). Appleton's theory is supported by research (e.g. Palsdottir, 2014; Sonntag-Öström et al., 2015). However, the enclosure should be balanced by openness in order to be experienced as restorative since a forest which is too dense can lead to a feeling of insecurity, which is what occurred with some participants in rooms 3 and 7. This is in line with a study by An et al. (2004), which shows that medium forest den-

sity allows the brain to relax as measured by activity in the frontal cortex; whereas a 100% forest density increases brain activity and pulse rate (An et al., 2004). The disagreement as to whether pines provide a feeling of safety or insecurity in room 7 indicates that vegetation types for the enclosure should be selected with caution and that a variety of different types of vegetation should be present in order to appeal to a broad range of people. The preference for beech forest over pine forest for restoration is supported by a study by Annerstedt et al. (2010), which was conducted in Sweden, where both environments are naturally present.

4.2. Sensory stimulation

Neither Appeton's nor Ulrich's theory entails descriptions of the importance of the sensory stimulation in the environment, but this seems to be an important aspect in feeling relaxed according to the participants. Rooms 3 and 4, which are rated highest with regards to restoration, are both described as having a diverse range of sensory stimulation by the participants. These findings are in accordance with Rachel and Steven Kaplan's attention restoration theory (ART) (1989). The theory emphasizes how it is important for people to feel fascinated by the environment through soft sensory stimulation in order for the restoration of cognitive resources to occur (Kaplan, 1995).

4.3. The 8 perceived sensory dimensions

One of the main research questions was how the participants would experience the eight different rooms in the Health Forest Octovia® with regards to promoting psychological restoration, and the extent to which the experiences would be in accordance with the aims of the 8 PSDs, upon which the rooms were designed. According to Grahn & Stigsdotter's research, the PSDs which are positively correlated with restoration and inversely correlated with stress are *serene*, *nature, rich in species and refuge*, with the highest preference for the PSD *refuge* (Grahn & Stigsdotter, 2010). Subsequent research on preferred PSDs in relation to stress reduction found *serene* to be the most preferred (e.g. De Jong et al., 2012; Grahn & Van den Bosch, 2014). The present findings support Grahn & Stigsdotter's and the subsequent research on preferred PSDs by showing a preference for the same four PSDs for restoration with *serene* (room 4) being the most preferred, followed by *rich in species* (room 3), *refuge* (room 8) and *nature* (room 7). When combining Grahn & Stigsdotter's research with the present findings, an optimal forest environment for psychological restoration should include these four PSDs along with the presence of an enclosed and open area with a view, diverse sensory experiences and an entrance with dense vegetation. These qualities and spatial aspects are illustrated in Fig. 12.

Fig. 12 Grahn and Stigsdotter's research on PSDs does not entail a spatial description of several of the PSDs (see Fig. 1). The present findings on the spatial aspects of openness and enclosure related to restoration may, therefore, enrich the PSD descriptions especially with regards to designing restorative natural environments.

How the man-made interventions are experienced is also an interesting aspect in relation to designing restorative spaces. Natural/organic shapes and nature-like interventions are, in general, preferred by the participants, for example, the round shape of room 3 as opposed to, for example, the rectangular shape of the lawn in room 2, or the constructed pond in room 3, which was experienced differently when it became more natural looking. Research comparing the restorativeness of mixed built and natural environments also found that the most natural scene type was preferred for restoration (Tenngart Ivarsson & Hagerhall, 2008; Tyrväinen et al., 2014).

4.4. Memories and associations

Research points towards a relationship between childhood memories and preferences for and experiences of particular natural environments (Adevi & Grahn, 2012; Milligan & Bingley, 2007). The present findings support this notion by showing a link between childhood memories and environmental preferences in the forest. This is seen in the experiences of room 7, where the participants who had positive memories related to being in pine forests, evaluated the pines positively, whereas the participants with no such memories were more inclined to have a negative evaluation. This implies that the specific environment where users grew up should be taken into account when designing restorative natural environments for user groups. This may, for example, be relevant when designing restorative environments for special and/or vulnerable groups like immigrants or refugees, whose childhood environments may differ significantly from that of their present location.

One should also pay attention to any possible unwanted associations when choosing design features since they may have negative

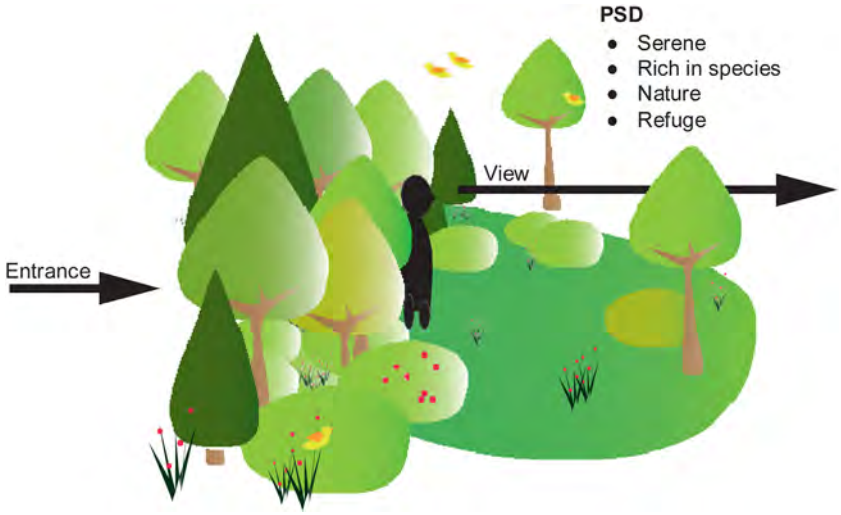


Fig. 12. Illustration of the optimal restorative forest environment combining the PSDs of serene, rich in species, nature and refuge with the spatial dimensions of a both closed and open organic shaped space.

connotations as in the case of the use of gravel on the forest path, which several of the participants associated with graveyards.

4.5. Implications for landscape design, planners and stakeholders

Based on Meyer & Brüger-Arndt's (2014) recent study on the state of research-based knowledge in the field of forests and human health and the results of this study, there is little doubt that forest environments can have health promoting effects, which shows that there is potential for cooperation between the forest sector and the health sector with regards to designing and using forest environments for mental health promotion.

The present findings indicate that the restorative effect of the forest environment can be reinforced by using the PSDs as a planning and design tool. The health forest Octovia® is the first forest environment where the PSDs have been intentionally implemented, and the findings, in general, show good accordance between the participants' experiences and the intentions of the PSDs (apart from room 5 representing the PSD cultural) (Stigsdotter et al., 2014).

Having demonstration facilities like the health forest Octovia® and a design manual (Stigsdotter et al., 2014) means that municipalities and other stakeholders in the area have the opportunity to both study the implementation of the PSDs in real life natural environments and have a step-by-step manual for implementing the PSDs in their own planning and management of local natural environments. Several municipalities in Denmark have already included the PSDs in their nature and health strategies; they have previously reported that it has been difficult to transfer the knowledge from research into comprehensible management tools. However, the demonstration site Octovia® provides a means of making the PSD tool more accessible for users outside the research environment.

4.6. Limitations of the study

Using an arboretum as a research location creates a weakness with regards to generalization since the environment is quite unique in terms of diversity. However, it can be seen as a best case environment for creating health-promoting forests, where elements in the design can be transferred to a more homogeneous forest environment. The Arboretum as a site also has some limitations due to the presence of unique plants and restrictions on design changes and plant varieties. The use of several different interviewers represents a possible bias, although the interviewers were instructed in how to conduct the interviews, there will still be inter-interviewer variabilities. The relatively small number of participants and the fact that only females were involved also presents limitations with regards to generalizing the findings to a larger community. The findings should, therefore, be seen as providing gender-dependent indications that need further research with larger mixed gender samples in order to support the validity of the findings in a more general context.

Room 4 is rated the most restorative room, but it is also quite unique for a forest environment due to the presence of a lake. Therefore, it would have been interesting to have had an additional room with the same features and qualities as room 4, but without the lake feature since one could argue that it makes the characteristics of the room difficult to transfer to a more traditional forest environment. A study by Sonntag-Öström et al. (2015) also found that a forest environment which included a lake was considered to be the most restorative, which indicates that the lake feature may be essential for restorativeness. However, the spatial aspects and vegetation types in room 4 can be generalized to a more traditional forest environment without a lake.

5. Conclusion

The existing research and present findings within the area of health-promoting forest environments suggest that the use of forests to promote mental health has potential. The findings indicate that the health promoting potential of the forest environment can be enhanced by designing with the PSDs as guidelines. The findings further provide new insight into which qualities and spatial features are preferred for restoration and support the results of previous research regarding the preferred PSDs for restoration. The results need further research with larger samples to confirm their reliability and to determine whether they can be generalized to more traditional forest environments outside the research location.

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Appendix A.

Interview guide to the Health Forest (the same questions are repeated in each room)

Thank you for participating in this interview. Now we will walk through the eight rooms together. I each room I will ask you the same questions. Please try to be as elaborate and nuanced in your answers as possible.

Now we walk into room X.

1 What is your impression of this room in regard to finding relief from stress?
2 What is it in particular that you prefer/like in this room in regard to finding relief from stress?
3 Can you explain why?
4 From a scale from 0 to 9, where 9 represents feeling completely relieved from stress and 0 represents no feelings of stress relief, how do you perceive your possibility to find stress relief in this room?
5 Is there anything you find disturbing in regard to feeling stress relief? Anything in your opinion that should be changed? Anything that is missing?

Is there anything you would like to add or elaborate on before leaving the room?

Appendix B.

Interview guide to the Health Forest (the same questions are repeated in each room)

Thank you for participating in this interview. Now we will walk through the eight rooms together. I each room I will ask you the same questions. Please try to be as elaborate and nuanced in your answers as possible.

Now we walk into room X.

1 What is your impression of this room in regard to finding relief from stress?
2 What is it in particular that you prefer/like in this room in regard to finding relief from stress?
3 Can you explain why?
4 From a scale from 0 to 9, where 9 represents feeling completely relieved from stress and 0 represents no feelings of stress relief,

how do you perceive your possibility to find stress relief in this room?

5 Is there anything you find disturbing in regard to feeling stress relief? Anything in your opinion that should be changed? Anything that is missing?

Is there anything you would like to add or elaborate on before leaving the room?

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