

Bachelor Thesis

**Mystery and Spaciousness and their Effect on Valence and Level of Engagement
of Stories in the Context of Virtual Nature Images**

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28th of February, 2022

Abstract

Background: As a result of a demographic shift, age-related problems like loneliness are becoming more prevalent. Previous research indicates that virtual natural environments and the manipulation of their components mystery and spaciousness can help to reduce loneliness by facilitating conversation and telling ones personal experience and associations. **Aim:** This study analyses whether mystery and spaciousness affect the valence and level of engagement of the stories older adults have towards virtual nature imagery. Moreover, it will be analysed if valence and level of engagement are correlated. **Methods:** A mixed-methods approach has been used to collect and analyse the stories and associations of 15 older adults over the age of 65, who were living in Germany. Manipulation of mystery and spaciousness resulted in four different virtual nature scenes as a form of stimuli to collect data. A deductive and inductive approach was used to code the dependent variables of valence and level of engagement that were both on an ordinal scale. **Results:** While there was no significant difference in terms of level of engagement for the scenes, a significant difference in regards to valence was found when comparing all scenes ($p < .01$). It has also been shown, that scenes with low spaciousness and low mystery result in significantly lower valence of stories than in comparison to scenes with high spaciousness and either low mystery ($p < .01$) or high mystery ($p < .01$). Furthermore, valence was not correlated to level of engagement ($p = .12$). **Conclusion:** The findings for level of engagement and whether valence and level of engagement are correlated were not in accordance with previous studies, while those of valence are debatable when compared to research in the past. However, the answers of the participants give assumption that other variables could be worthwhile to investigate in the future.

Keywords: Virtual Nature, Mystery, Spaciousness, Valence, Level of Engagement, Storytelling

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Introduction

1.1 Aging and loneliness

With the world population growing over the decades and life expectancy increasing as a result of various factors, the overall age distribution shifts from more younger individuals to an overall older population (WHO, n.d.). It is expected that the aging process will continue to accelerate in the next decades as a consequence of increased life expectancy and lower fertility (Lutz et al., 2008). This change in the demographics results in a demand for more tailored psychological treatment aimed at older individuals. To be specific, loneliness is a prevalent problem among older individuals and is a factor that is associated with a multitude of different psychological and physical problems (Compernelle et al., 2021). Loneliness can be described as the inadequate satisfaction of social contacts with other individuals like family and friends due to a low number of significant available contacts and superficial socialization (Cloutier-Fisher et al., 2011). Based on this, the individual experiences an insufficient fulfillment from one's social network qualitatively or quantitatively (de Jong Gierveld, Keating & Fast, 2015). As a consequence, the individual might suffer from both psychological and physical problem.

Older adults may require significant social support from caregivers due to diminishing health as with growing age health problems can appear and this in turn makes them more vulnerable to the consequences of loneliness (Cornwell & Waite, 2009). The problem of loneliness and its consequences affects older adults due to factors like widowhood and diminished personal economic wealth (Ong et al., 2016).

According to literature, older adults are severely affected by depression and as a result, an overall great burden of disease exists for these individuals (Conner et al., 2010). Moreover, loneliness in older adults can increase the risk for coronary heart disease and risk of stroke (2020). To continue, loneliness is associated with a multitude of negative effects such as sleep problems and a reduction in health-enhancing behaviour (Ong et al., 2016).

In residential homes and assisted living facilities, loneliness in older adults is also a prevalent problem that affects the mental and physical health of the individuals (Jansson et al., 2017). Individuals living in these facilities reported significant feelings of loneliness and sometimes stated that they felt not visible to other individuals in such facilities (Jansson et al., 2020). Loneliness in

nursing homes also influences the needs and demands of older adults in terms of care and assistance (Jansson et al., 2020).

To counteract the symptoms and the diminished mental and physical health that comes from loneliness, a variety of treatment options can be utilized. For example, Banks et al. (2008) have shown, that animal-assisted therapy with the use of either a living or a robotic dog, has significantly reduced loneliness in older adults. Natural environments can also be a potential source for treating the aforementioned problems due to the variety of benefits it provides such as reduced events of diabetes and overall declining stress in stressful life situations (Freeman et al., 2019).

1.2 Natural environments

A high number of older adults indicated that experiencing nature is an important part for them (Yeo et al., 2019). Research has shown that for cognitively impaired individuals in residential homes, natural environments can increase the overall quality of life, including for people that have dementia (Yeo et al., 2019). As seen in literature, nature can be a source for improving one's physical and psychological state through various exercises and activities around natural environments (Barton & Pretty, 2010). Besides physiological and mental benefits, natural environments can also have positive effects on socialization. Natural areas can promote socialization and encourage contact with other people (Korpela et al., 2014). Thus, natural environments could counteract against loneliness.

Natural environments also have the benefit of restoring attention. The Attention Restoration Theory (ART) from Kaplan and Kaplan (1995) is describing how attention can be used up and how natural environments can restore it. Voluntarily paying attention to relevant information and avoiding distracting information in highly stimulating areas can only be done for a limited amount of time and can lead to mental fatigue. In comparison, involuntary attention does not result in said fatigue as attention is directed towards components that are fascinating and are effortless to concentrate on (Stevenson, Dewhurst, Schilhab & Bentsen, 2019).

Natural environments can have many variations in terms of appearance and their consequential effect they have on the individual who experience them in the context of restoring attention. For example, by displaying elements of mystery (e.g. adding hills) and spaciousness (e.g. low tree density), fascination is caught in an effortless way (Otten et al., 2022). The component mystery describes how a setting can contain more information than what is physically visible at the moment (Herzog, 1988). As such, natural environments that are found to have elements of hills and mountains

that are concealing the view can be high in the component of mystery. Mystery works in such a way, that it is cognitively stimulating for the viewer to speculate about the hidden information and thus, positive emotions are evoked (Herzog, 1988). The second component spaciousness describes how many objects can be found in a nearby environment. In regards to nature environments, spaciousness can be found in various ways such as the tree density of a forest (van Houwelingen-Snippe et al., 2020a).

Besides these two components, there are other nature variations available that could capture attention, but as mystery and spaciousness are also related to social function, they are of greater importance in the context of this study. While natural environments have a profound effect on the individuals that watch them, not everyone has the accessibility to experience nature views due to a variety of causes. At first, older adults may not voluntarily visit natural environments due to fear of falling and the increased complications of walking outside (Sugiyama et al., 2009). To continue, adverse effects of medication and mobility issues can prevent individuals to experience the benefits of natural environments (Appel et al., 2020). In these cases, the use of virtual interventions can be a good alternative in order to overcome these barriers while still experiencing nature and its advantages in a virtual setting.

1.3 Natural Environments in the Virtual World

Natural environments can be experienced both in a physical as well as a virtual setting through the use of digital photography, virtual reality, and more. Virtual reality for example can elicit and recreate a situation from the real world into a virtual setting and create an experience that is similar to that of the physical counterpart (Liszio et al., 2018). Depending on the technology that is used, the individual can interact with the virtual environment and thus, the user is more immersed in another world (Lundstedt et al., 2021). Besides virtual reality, virtual nature scenes in the form of photographs and videos can give the opportunity to experience natural environments with similar effects, which is the focus of this study.

Virtual natural environments provide a variety of physiological and mental effects such as a reduction in heart frequency and general better mood (Nukarinen et al., 2020). Another significant point is that seeing virtual natural environments can help with relaxation in stressful situations or stressful mood (Liszio et al., 2018). Experiencing virtual nature can also decrease physiological aspects such as blood pressure and heart beat frequency (Nukarinen et al., 2020). Moreover, a virtual nature environment can promote personally engaging and positively valenced associations, which

in turn might facilitate conversation between other individuals through the component of telling one's personal story and memories (Otten et al., 2022).

The process of storytelling can be defined as a form of communicating personal experience and memories to another individual and is a self-reflective activity for the one that is telling their story (Balyasnikova, & Gillard, 2018). In the past, interventions aimed at promoting storytelling were able to decrease loneliness (Alexandrakis, 2017). The narration that is given during the storytelling displays the identity and experience the storyteller have of themselves and shows the differences but also the commonalities between one individual and the listeners. A study by Westerhof and Bohlmeijer (2012) explains that a story can have components of identification, where the author sees the story that they are telling as a part of their own identity. The stories the individuals are telling can also have varying degrees of valence (Voutilainen et al., 2014). To continue, when older adults tell their stories, the depth of these can be differing, an aspect known as level of engagement. Virtual images of nature might be used as an opportunity for storytelling and to elicit conversation between older adults because of different components and their effect on the individuals that see them (Otten et al., 2022).

Virtual natural environments can be manipulated through various components that can differ in their extent, like the absence or presence of hills (mystery) or varying tree density (spaciousness) as found in real environments, which can affect the attitude and the level of engagement individuals have on virtual nature (Otten et al., 2022). Besides the aforementioned two components, there are also other virtual nature variations available. However, since the social function of said images and the potential of telling ones story through virtual nature environments will be investigated, only these two will be analysed. When older adults view virtual nature environments, their stories can have differing attitudes, also known as valence. Valence in the context of virtual and real nature environments has been investigated in previous studies to see, what alterations of the environment can result in which valence rating (Otten et al., 2022).

For mystery in the context of valence, it has been shown that nature images high on mystery are more fascinating and are given better preference ratings (Marois et al., 2021). A study by Ikemi (2005) has also shown that individuals have a strong preference for residential facades that are fully concealed by leaves than in comparison to only partly concealed or entirely visible. As such, virtual nature images that contain elements of mystery might also provide the same effect as when experiencing the element in real nature.

Besides mystery, spaciousness in the context of valence was also investigated in previous studies. When looking at valence, spaciousness can be seen from different perspectives and is rated

differently depending on the context and it is not clear whether high or low spaciousness can result in positive valence. A study by Coeterier (1996) has shown that dutch individuals from the north see spaciousness in nature as something positive due to the better view, while individuals from the south see it as a negative component due to the lack of plants and other natural parts. Another study by Gallagher (1977) has shown, that spaciousness is rated negatively in the context of preference. To continue, an other study has shown, that spacious canyons for example are more liked than narrow canyons (Herzog, 1987).

Literature has shown that besides valence, individuals who were watching virtual nature environments also tend to connect them with meaningful and personal experiences from the past, which encourages them to share these moments with others (Otten et al., 2022). As such, the level of engagement of the stories individuals have when watching virtual nature imagery can be influenced by the manipulation of mystery and spaciousness.

When looking at the level of engagement, previous research showed that individuals who have watched virtual nature scenes high on mystery (hills present) also had a corresponding high level of engagement of their stories (Otten et al., 2022). As such, implementing components of mystery like hills could lead the participant to connect these scenes with experiences from their past and express them to the individuals around them.

To continue, spaciousness also has an effect on the level of engagement. Virtual nature scenes that are high on spaciousness (low tree density) have been shown to increase social aspirations of individuals and thus, are more inclined to share meaningful memories about those scenes (van Houwelingen-Snippe et al., 2020a). Based on this, a low tree density could result in the participant showing a high level of engagement towards the virtual nature scenes.

While scarce, the available literature has demonstrated how mystery and spaciousness affects the valence and level of engagement of the stories of the individuals that watched virtual nature scenes. It can be helpful to validate past findings by conducting further research in this area and to replicate said results by utilising virtual nature scenes that have been manipulated with the absence or presence of mystery and spaciousness. To continue, by further investigating the effect of mystery and spaciousness, guidelines for the creation of virtual nature scenes can be made for the future use of virtual nature scenes as a form of psychological intervention aimed at promoting storytelling. At last, interventions that implement storytelling can decrease loneliness and as such, it can be beneficial to investigate how the manipulation of virtual nature scenes in terms of mystery and spaciousness is able to promote storytelling in older adults.

1.4 Significance of study and research questions

This study can help to analyse how different virtual nature scenes influence the valence and level of engagement the older individuals have when looking at such scenes. The findings of this study can help available treatment options to be more manageable and comfortable for older adults as well as to assist future research with more information on this topic. To continue, interviews will be conducted to analyse attitude and memories in order to see how and what older adults attribute and experience when seeing virtual nature scenes. Given how mystery is generally liked by other individuals and how spaciousness can be viewed as either positive or negative, it can be a good addition to further expand literature on how mystery and spaciousness affects the valence of stories and what level of engagement the participants show when viewing virtual nature scenes.

The current literature can also be expanded on whether valence and the level of engagement in the context of virtual nature imagery are correlated, as there is only minimal research available that analysed this possible relationship. By contributing to this sub-topic, more precise guidelines and directions can be given when wanting to create virtual nature scenes as a form of psychological intervention aimed at decreasing loneliness. To continue, by analysing whether these two variables are correlated, the potential of virtual nature images to evoke positive emotions and memories and to facilitate storytelling can be increased as more accurate and elaborate instructions can be given when wanting to create virtual nature scenes as a form of intervention.

With regards to the previous explanation on how this study can help to add more literature and to investigate the potential of virtual nature scenes as a form of psychological intervention, the following research question has been proposed: „How can mystery and spaciousness affect the valence and level of engagement of the stories older adults have towards virtual nature imagery?“. To answer this research question, the stories of older adults will be analysed. By investigating the content and depth of the stories the participants tell, it can be analysed whether virtual nature scenes can be used as an intervention to facilitate storytelling and thus enable older adults to possibly connect with other individuals.

To continue, the following subquestion will be given and investigated: „Do valence and level of engagement of the stories older adults have towards virtual nature scenes correlate to each other?“. By analysing this subquestion, current treatment can be more effective by changing the given imagery according to how the components of mystery and spaciousness are affecting older individuals and whether it can assist in stimulating real conversation.

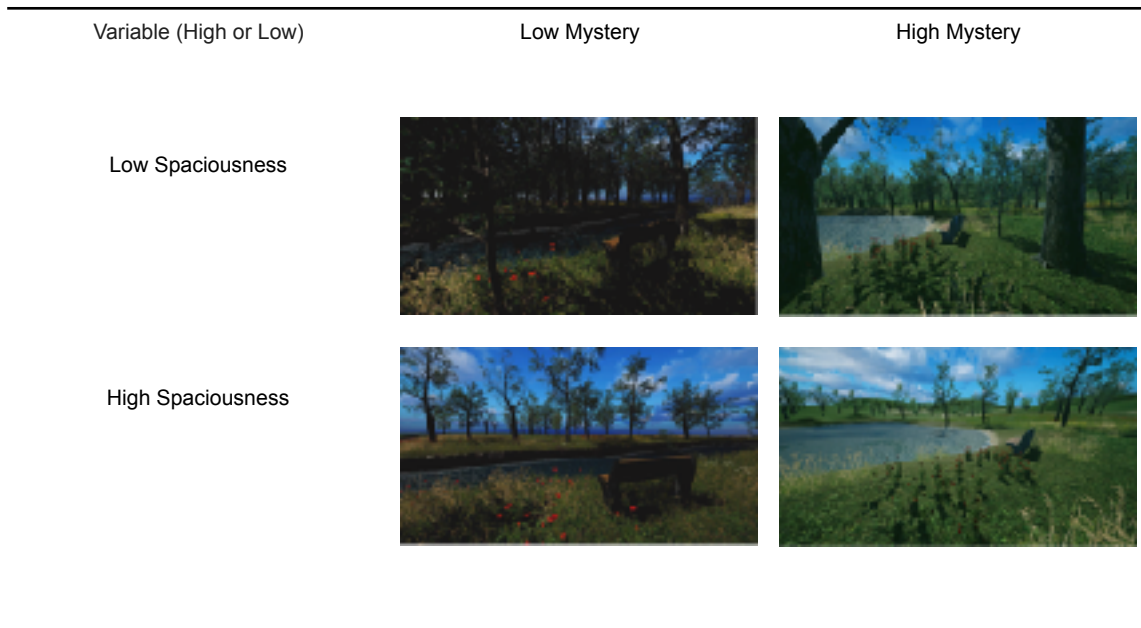
Methods

2.1 Research design

The study is utilising a mixed-methods design to answer the research questions. As such, semi-structured interviews have been used to gather relevant data on the use of virtual nature as a stimuli. For general analysis on the research questions, qualitative and quantitative analysis has been conducted.

2.2 Stimuli

Four videos of fictive digital-animated nature scenes have been created using the software “Virtual Nature“ from the Behavioral, Management, and Social Science Department of the University of Twente (BMSLab, 2020) and shown to the participants as 20-30 second long videos. When using the software, it is possible to develop virtual nature environments containing different components such as hills, flowers, and rivers. These components, as well as other parts of the environment, can be manipulated according to the principles of mystery and spaciousness. Mystery has been manipulated by utilising hills (adding mystery) or deleting them (no mystery). To continue, spaciousness has been manipulated by having fewer trees (more spaciousness) or adding more trees (less spaciousness). Manipulating mystery and spaciousness led to a total combination of four scenes that have been created. Figure 1 shows the scenes and their manipulation of the virtual nature environments that have been seen by the participants.

Figure 1*Virtual Nature Scenes (Manipulations of Mystery and Spaciousness)*

Notes. Low Mystery: Hills absent. High Mystery: Hills present. Low Spaciousness: High Tree Density. High Spaciousness: Low Tree Density.

2.3 Participants

Participants have been recruited through contact with a nursing home in Germany. Here, the participants were visited either in their corresponding room in the nursing home or for people who could still live partly independent, at their house or flat in collaboration with the ambulatory care service. The inclusion criteria for this study were a minimum age of 65 years and having no mental and physical disabilities that could impair the interview and data collection process. The total number of participants was 17. One participant was excluded from the study as the interview duration exceeded the normal duration and was considered an outlier, while another individual revoked their participation from the study after conducting the interview. Based on this, the final number of participants was 15. All participants were able to speak German. Participants have been visited physically in accordance with the current COVID-19 policies at that time.

2.4 Procedure and materials

At first, participants were introduced to the study and were informed by utilising a general information sheet containing all necessary information. After answering the questions the participants had, informed consent has been introduced and been given by the participant. The participant stated relevant demographics at the beginning of the interview and the first virtual nature video was shown. At first, a scene with high spaciousness and low mystery was shown. The following scene was about low spaciousness and low mystery. To continue, the third scene was about high spaciousness and high mystery. The last scene was about low spaciousness and high mystery. The order stayed the same for every participant. After showing the participant a scene and giving them 20-30 seconds to let it affect them, it was instructed to explain whether they have seen a similar place like shown in the scene or whether they have a memory about such a place and what their opinion towards the scenes are. For about five minutes, the participants were able to give their answers before proceeding to the next scene. At the end of the interview, the participant had the opportunity to withdraw their consent and to ask further questions.

Besides information sheet and informed consent, an interview scheme (available in the appendix) has been used to structure the conversations between participant and research, as well as to ensure that the manipulation check and the timeframe were in a correct manner. Some interview questions that have been asked were: “Have you been at a similar place before?” and “Does this place remind you of something?”. Depending on the situation and the understanding of the participants, some questions were adapted to be more clearer in the later interviews. As the research question was about the memories of older individuals, the interview scheme tried to assist with different components by using a set procedure to gather the necessary information by describing the order and instructions and to assist with the data collection process. The interview scheme consists of a list of points that describe how the interview has to be conducted, what materials have to be present, and how much time is required for each action. The content of the interview scheme also assists in clarifying and collecting the dependent variables, namely the ratings toward the scenes (valence) and the depth of memories the individual shares (level of engagement). The questions in the interview scheme were used as a guideline and as such, it was possible to change the questions according to the setting, the participant and the impression of previous interviews based on their effectiveness.

At last, a laptop has been used to display the stimuli towards the participants, while a smartphone was utilized to record the answers the participants gave during the interview. For the later

analysis, the software “AmberScript“ has been used to transcribe the verbal answers into written sentences, that can be analysed in a quantitative manner.

2.5 Analysis

For this study, an inductive, as well as a deductive approach has been used based on the framework that has been given by previous research. For the deductive approach, Otten et al. (2022) have shown, that the statements from older individuals display different levels of attitudes towards virtual nature stimuli (also known as valence). As such, the codings and labels for valence have been determined, namely “Negative Valence“, “Neutral Valence“ and “Positive Valence“.

When qualitatively analysing the text, labels have been assigned to the personal statements the participants gave, a process known as labelling. For the inductive approach, several coding cycles have been conducted to set up the codes and labels for the different levels of engagement. In the first coding cycle, it has been seen that participants had different levels of engagement when telling about their memories, ranging from no memory at all, to detailed descriptions with information and emotions about their corresponding memory. As such, the first labels have been given, describing the different levels of engagement. The second cycle continued with further analysis, by changing the already given labels to be more fitting and by increasing or decreasing the labels of level of engagement for some citations after repeated reviewing. As such, four to five citations that were first labelled as “General Memory“ have been omitted and changed to “Reminiscence Memory“ due to the citations containing short but meaningful personal experiences and due to the low amount of citations labelled “General Memory“. The third and fourth cycle included continuous coding and labelling for additional findings such as naming the same place or region when looking at all participants interviews, as well as the type of tree, the tree status (e.g. ill, thick) and mentioning water or the bench when looking at the scenes. The total number of final codes for the level of engagement were four (No Memory, Specific Memory, Reminiscence Memory, Storytelling Memory). After reviewing each statement and coding according to the variables, the statistics have been set up.

The quantitative data first had been inspected in terms of descriptives like frequencies of valence and level of engagement. For the quantitative analysis and to answer the research question: “How can mystery and spaciousness affect the valence and level of engagement of the stories older adults have towards virtual nature imagery?“, Friedman-Tests have been performed. As a form of post-hoc tests, Wilcoxon-Signed-Rank Tests have been conducted to see which groups statistically

differ from each other. To answer the second research question: “Do valence and level of engagement of the stories older adults have towards virtual nature scenes correlate to each other?”, Spearman-rank order correlations have been computed. For all statistical tests, the significance level had been set at $p < .05$.

In regards to the qualitative data, Atlas.ti Version 9 has been used. For quantitative data, SPSS Version 25 has been used. Ethical approval has been given on the 21.10.2021 from the Ethics Committee of the University of Twente from the Behavioral, Management and Social Science Department. The approval number was 211218.

2.6 Outcome measures

The study was analysing two dependent variables. The first variable valence was measured on three points on an ordinal scale, ranging from -1 to 1. Negative Valence (e.g.: “No, I don’t like this scene because it is too shady, the sun does not come through.”) indicated that the participant generally disliked the scene. Neutral Valence (e.g.: “I only find this scene only moderately fine.”) indicated that there was no significant emotion in either direction. At last, positive valence (e.g.: “Great photo, really great nature.”) showed that the participant generally liked the scene and said so in their stories.

Secondly, level of engagement was measured to see to what extent the individuals interacted with the scene and how deep their stories were. The variable was measured on four points on an ordinal scale, ranging from 0-3. No Memory (e.g.: “At the moment I do not know what this should remember me of.”) indicated that the participant had either no significant memory or did not give an answer to the questions. Specific Memory (e.g.: “This could be near the Dri-Land-See, because the Dri-Land-See is really big.”) indicated that the participant had some remembrance about the given nature scene and talked about a particular place or region but did not talk about personal memories. Reminiscence Memory (e.g.: “My father and me have searched for mushrooms and I had to stay at the bicycles as a child. It remembers me from this moment and I had shouted the name of my father and my father had laughed.”) indicated that the participant talked about personal memories that were tied to joint activities with family or friends for example or significant personal memories, but did not talk about a specific place or region. At last, Storytelling Memory (e.g.: “We were doing holidays in Denmark and there were these fish lakes with fishes in them and could sit there and go fishing. This remembers me instantly from that.”) indicated that the participant talked about a significant personal memory and stated one or more significant places or regions.

Results

3.1 Descriptive statistics

The total duration of each interview ranged approximately from 6 to 13 minutes and each participant has seen all four scenes, except for one participant that gave answers to the first three scenes. Table 1 shows the descriptive statistics for all total scenes, as well as for each individual scene, including both high and low mystery as well as high and low spaciousness.

Besides the manipulation of mystery and spaciousness, the participants have mentioned and acknowledged other parts of the virtual nature scenes and connected or mentioned them in the context of different emotions and feelings.

At first, some participants mentioned the bench that was present in all four scenes. Here, several individuals expressed how they would like to take seat and have a moment of rest (e.g.: “This would inspire me to have a great walk on a sunny day, to sit on the bench and to enjoy the view.“). The bench was also sometimes tied in with feelings of calmness and tranquility (e.g.: “It is very peaceful. The bench, you can sit there to be at the fresh air and to have a lunch break.“).

To continue, the blue spaces (rivers, lakes) that were present during the scenes have been frequently mentioned by the participants. While previous elements like the bench and the flowers were mostly discussed by the participants in terms of emotions and valence, the blue spaces were mostly connected to memories the participants had about their hometowns or meaningful events in their life. Interestingly, the form of the blue space was important in whether the participants had a memory to tell about (e.g.: “Yes, this is the Schieferkuhle, exactly like this I would say. There is the mountain, there is the sea.“).

Some participants also mentioned the flowers that were present during the scenes. As such, they were able to identify the category of flower and expressed the valence they had towards these flowers (e.g.: “The poppies, the water, these are all things that I love.“). Flower were almost exclusively mentioned in a positive context and were either rated positive or given a description of the participants when they tried to find out what kind of flowers they were.

Moreover, a part of the sample talked about the brightness of the scene with low mystery (hills absent) and low spaciousness (high tree density). While not analysed, some participants expressed their view that this particular scene is too dark and dim (e.g.: “This looks a bit grim.“). Al-

most all comments that contained statements about the low brightness were mentioned in a negative or neutral context.

For valence ($N=59$), the answers varied from negative to positive for Scene 2 and Scene 4, while Scene 3 and Scene 1 had ratings ranging from neutral to positive. The total valence can be described as mostly positive (71.2%, e.g.: “Yes, this is how it would look like when it already grows thicker, when it is not so bare anymore. I like it more that way.”), with neutral (22.0%, e.g.: “Not positive or negative.”) coming next and negative (6.8%, e.g.: “It would be a bit scary for me if I would sit there.”) being the last. Positive valence was most frequently reported (93.3%) for scenes that were high in spaciousness (low tree density) and had either low mystery (no hills) or high mystery (hills present). Neutral valence was most frequently reported (53.3%) for the VN image that had low mystery and low spaciousness. The same VN image had been given the most (20.0%) negative valence from the participants.

Level of engagement that was shown from the participants to the scenes ($N=59$) varied from no memory or answer to explaining in great detail their memory about a particular event that resembled the given scene, also called storytelling memory in this study. Overall, 40.9% were classified as no memory (e.g.: “No. Nothing like that. No, I cannot remember something like that.”). To continue, 23.6% were classified as a specific memory (e.g.: “My first impression is that this reminds me of my home in Pommern. We had a lake. Yes, we had a meadow.”), 17.0% as a reminiscence memory (e.g.: “This reminds me of my time in treatment. Every afternoon, we made a hike through the nature and in the background was the forest and everybody was happy. Everyone was joyful.”) and 18.5% as a storytelling memory (e.g.: “Yes, this is the Schieferkuhle. Exactly like this I would say. There is the mountain, there is the sea. You could also do ice skating when you had a dry winter. It is exactly like that, and here, we were walking up diagonally.”) The most engaging memories were reported for the VN image that had low mystery (no hills) and low spaciousness (high tree density), while the least engaging memories were reported for the VN image that had high mystery (hills present) and low spaciousness (high tree density). In comparison, the least engaging memories were given for the VN image high on mystery (hills present) and low on spaciousness (high tree density).

Table 1.

Individual and Total descriptives statistics for all four VN images (Valence, Level of engagement)

Variable (%)	Scene 1 (Low Mystery, High Spaciousness, N=15)	Scene 2 (Low Mystery, Low Spaciousness, N=15)	Scene 3 (High Mystery, High Spaciousness, N=15)	Scene 4 (High Mystery, Low Spaciousness, N=14)	Total Observations for all Scenes (N=59)
Negative Valence	0.0 %	20.0 %	0.0 %	7.1 %	6.8 %
Neutral Valence	6.7 %	53.3 %	6.7 %	21.4 %	22.0 %
Positive Valence	93.3 %	26.7 %	93.3 %	71.4 %	71.2 %
No Memory	40.0 %	33.3 %	33.3 %	57.1 %	40.9 %
Specific Memory	33.3 %	13.3 %	33.3 %	14.3 %	23.6 %
Reminiscence Memory	13.3 %	26.7 %	6.7 %	21.4 %	17.0 %
Storytelling Memory	13.3 %	26.7 %	26.7 %	7.1 %	18.5 %

Notes. VN: virtual nature. N: number of observations. Low Mystery: absence of hills, High Mystery: hills present. Low Spaciousness: high tree density, High Spaciousness: low tree density.

3.2 Analysis of mystery and spaciousness on valence and level of engagement

To test, whether the high or low levels of each component, namely mystery and spaciousness, had an effect on the level of engagement and the valence of the stories of the participant, Friedman-Tests has been performed including all four scenes. As such, there was a significant difference between the different scenes and their corresponding value of mystery and spaciousness in terms of valence, $\chi^2(3) = 18.62, p < .01$. To see what groups are statistically different from each other, Wilcoxon-Signed-Ranks Test have been conducted as a form of post hoc tests. Based on this, there was a significant difference between scene 2 (low mystery and low spaciousness) and scene 3 (high mystery and high spaciousness), $Z = -2.80, p < .01$ based on positive ranks. To continue, there was a significant difference between scene 2 (low mystery and low spaciousness) and scene 1 (low

mystery and high spaciousness), $Z = -2.92$, $p < .01$ based on positive ranks. Taking the post hoc tests into account, it can be said that scene 2 (low mystery and low spaciousness) has been rated significantly more negative when compared to scene 1 (low mystery and high spaciousness) and scene 3 (high mystery and high spaciousness).

Next, the influence of the manipulations from mystery and spaciousness on the level of engagement were analysed. As such, there was no significant difference between the different scenes and their corresponding value of mystery and spaciousness in terms of level of engagement, $\chi^2(3) = 2.07$, $p = .56$.

3.3 Correlation analysis between valence of level of engagement

To continue, Spearman-Rank order correlation had been computed to see, if valence was correlated to the level of engagement the participants showed. Valence was not significantly correlated to the level of engagement the participants had towards all VN images ($r(14) = .42$, $p = .12$). Based on this, it can be said, that regardless of valence the participants gave towards the scenes, the level of engagement of the participants were not related to each other.

Discussion

4.1 Mystery and spaciousness in the context of valence and level of engagement

This study aimed to get a better look at how virtual nature and its individual characteristics, especially mystery and spaciousness, can affect the valence and level of engagement of the stories the participants have towards virtual nature imagery. For the general descriptives, it can be seen that when it comes to valence, scenes with high spaciousness and either low or high mystery are most suitable to be used as a method to bring up positive engaging stories. However, when it comes to the level of engagement of the stories, scenes with low mystery and low spaciousness and to some extent scenes with high mystery and high spaciousness are most suitable. As such, when taking into account both valence and level of engagement of the stories, the scene with high mystery and high spaciousness could be appropriate to bring up both positive and engaging stories in older adults.

To continue, the first research question was: “How can mystery and spaciousness affect the valence and level of engagement of the stories older adults have towards virtual nature imagery?”.

The study has showed that there was a significant difference in valence when comparing the scene with low mystery and low spaciousness with the scenes with either low or high mystery and high spaciousness. As such, the scene with low mystery and low spaciousness was rated significantly lower than in comparison to the scene with low mystery and high spaciousness and to the scene with high mystery and high spaciousness. When looking at the results, it can also be said that the scenes with high spaciousness and either low or high mystery are rated significantly higher when compared to the scene with low mystery and low spaciousness. In terms of valence, these findings are debatable when seen in the perspective of literature. Previous studies have shown that mystery is a consistent predictor for high valence and thus, the findings are similar to that of other research (Herzog, 1988). For spaciousness and valence however, various studies came to different conclusions. Gallagher (1997) showed that spaciousness results in negative valence, while Herzog (1987) found out, that for canyons, spaciousness is more liked than narrowness. The discrepancies in literature could be attributed due to the type of nature that was shown. To give an example, Herzog (1988) used canyons as a stimuli to investigate valence in terms of spaciousness, which is a contrast to nature environments like forests that have different trees and plants. An explanation of the current studies findings can be found when further investigating the citations from the participants. Some participants have talked about the low brightness in the scene with low mystery and low spaciousness and how it creates feelings of being alone and gloominess. As such, the negative valence coming from this scene might have been due to other factors like that of brightness. Future research should aim at further analysing the combination between low mystery and low spaciousness while minimizing possible moderation effects.

To continue, it has been shown that no virtual nature scene shows greater level of engagement than the other ones. This finding is not in line with previous research. Van Houwelingen-Snippe et al. (2020a) have shown, that when individuals have viewed spacious virtual nature environment, they were more inclined to share experiences and had higher social aspiration (interacted more with other individuals). This could be attributed due to the order of the stimuli. Van Houwelingen-Snippe et al. (2020a) had a particularly significant effect when they have used a spacious nature scene first, followed by a dense scene. In contrast, the current study used a spacious scene first, continuing with a dense scene and then importantly, repeated this procedure for the rest of the interview. This difference could have lead to less level of engagement of the stories. Future research should conduct a similar study with an other order or amount of the scenes to see if the arrangement or quantity of the stimuli is a factor that can influence the level of engagement of the stories. For mystery and level of engagement, the findings are also not replicated when compared with previous

research. Otten et al. (2022) have shown, that virtual nature imagery high on mystery (hills present) show good level of engagement. In the current study, some participants were focussed on the lake that was visible during the scenes with the high mystery and mentioned a particular lake that has no hills. Some participants stated they do not have a memory of the scenes with high mystery as they were not able to recognize this lake in a scene with hills (e.g.: “No, I cannot recognize the Driland-Sea there. The place is too small for that.“). As such, it could be that the individuals do not show level of engagement of their stories since they were more focussed on the lake than to the hills and trees. Future research should therefore conduct a similar study but without the presence of blue spaces in order to have a higher focus on the effect of mystery.

4.2 Correlation between valence and level of engagement

This study also analysed whether valence correlates with the level of engagement. As such, the second research question was: “Do valence and the level of engagement of the stories older adults have towards virtual nature scenes correlate to each other?“. The results show that there is no significant correlation between valence and the level of engagement and as such, there is no relationship between the given valence and the shown level of engagement the participants had towards the virtual nature imagery.

These results do not align with current literature. In comparison, Otten et al. (2022) have shown that when individuals gave more positive valence towards virtual nature scenes, their level of engagement with these scenes was also greater. An explanation of the findings the current study has, could be found in the citations the participants expressed when telling about their memories. Some participants expressed a memory about collecting mushrooms when looking at the scene with low mystery and low spaciousness. It could be that some memories are tied to certain nature elements that are only available under specific circumstances (e.g. mushrooms grow with low or no light). Thus, scenes that have been rated negatively (e.g. the scene with low mystery and low spaciousness) could still show some level of engagement. Because of the scarce literature in terms of a possible correlation, future research could aim at replicating the study in order to give more insight whether a correlation between valence and level of engagement exists and what factors could be influential.

4.3 Strengths and limitations

Since this study has used qualitative research methods and combined them with quantitative analysis, the thematic and the answers can be investigated more deeply as the reasoning and related emotions and feelings are also expressed by some participants. Based on the comments the participants gave when rating the scenes, as well as sharing their memories, the data is more precise when compared to a solely quantitative approach (Anderson, 2010). Additionally, through the mixed methods approach (inductive and deductive), the coding and labelling process can reveal more underlying data and give better assumptions for future research that could have not been found and given with quantitative data alone.

To continue, the complementarity of a mixed methods approach (combining qualitative and quantitative methods) can give more insight into the corresponding results and can compensate the weakness of each standalone method. As such, the interviews, where qualitative data has been set as the framework, were further analysed by using quantitative methods and programs to get more statistical and meaningful interpretations. To give an example, by using a mixed methods approach, it has been revealed that for the scene with low mystery (hills absent) and low spaciousness (high tree density) the negative valence rating could have been partly due to the low brightness as shown by the citations of the participants.

While this study has helped to advance the research into the field of how virtual nature can influence the valence and level of engagement of older participants, some limitations are present. To start, some stimuli could have measured an unwanted component (brightness) when being shown to the participants. The virtual nature scene with low mystery and low spaciousness included some shadows from trees that were behind the point of view. This in turn could have resulted in more negative feelings and thus a negative valence for this scene, as participants frequently mentioned how dark and dim it was (e.g.: “No, this does not look good, because it is too shady and the sun does not come through.”). All comments that mentioned shadows and darkness in the context of negative valence were exclusively coming from the scene with low mystery and low spaciousness. As such, this particular scene might have received negative or neutral valence due to the lighting and not due to the components of mystery and spaciousness that were intended to be analysed in this study. For the future, caution should be taken when creating more scenes in order to avoid an unwanted moderation effect.

Nevertheless, while an unwanted component might have been included in the creation of the stimuli, this can also be seen as a positive aspect, since through the expressions and reasoning of the

participants, it has been shown that brightness could be a variable to explore for future studies. Without the qualitative part in a mixed methods approach, it would not have been possible to reveal that low brightness could have a negative influence on the valence the participants gave towards the scene.

To continue, since this study was partly conducted as semi-structured interviews, some biases could have influenced the validity of the results. As such, a wording bias could have taken effect. During the interviews, some questions were formed differently by the researcher in order to give participants who had minor cognitive problems a better opportunity to state their answer and to give other participants a better example of what is meant with the question. Based on this, some altered questions could have influenced the valence ratings and the level of engagement the participants could have given to the scenes. To give an example, instead of an open question (e.g.: “What kind of feelings do you have when looking at scene?”), closed questions like: “Ranging from not so good, neutral and good, what is your opinion on this scene?” have been asked to some participants. This in turn could have given the participants the perception that they can only give an answer that fits these three categories. Moreover, due to the aforementioned closed questions, some participants may have given only a short answer, consisting of one or two words instead of an elaborate answer.

However, since the interview questions have been adapted throughout the course of this study, more variance of data has been created and as such, more diverse perspectives and answers have been given by the participants. As a result, the data was able to show more underlying assumptions and yield more detailed memories and description of the given valence ratings.

At last, while the variance of data has contributed to the content of answers in this study, the adaption of the interview questions could have also resulted in non-standardized data. As a consequence, it is more problematic to compare the description of the answers to that of other participants and to previous studies in the same field. To continue, another consequence could be that the validity of the results might have been influenced by the non-standardized answers. At last, the coding and labelling of the data was based on different questions the participants have been asked and thus, due to the variety of the questions, the coding and labelling in terms of valence and level of engagement might have not been completely accurate.

4.4 Future research and recommendations

This study aimed at analysing the variables mystery and spaciousness in the context of virtual nature scenes and their influence on the valence and level of engagement of the stories of older adults. However, other variables as seen in literature could be the focus of further research. As such, the component of compatibility (e.g. the absence or presence of a bench) can be of interest for future research. While not of main focus for this study, some participants have mentioned the bench in the video and how they would like to sit there. These participants frequently associated the bench and the option for sitting with resting (e.g.: “The bench, that you can rest there. Nowadays, I would sit there, if it would be still there and if I would walk near there.“). Van Houwelingen-Snippe et al. (2020b) have shown, that certain elements that resemble tended nature, such as a bench can be associated with social presence. Future research therefore can investigate the possibility of whether compatibility elements like benches can influence the level of engagement of the stories of older adults when viewing virtual nature scenes and how the valence of their stories is influenced.

To continue, the component of soft fascination could be analysed for the future. Several participants have mentioned the river and the lake in each scenes and told about a memory regarding these (e.g.: “This reminds me of our holiday in Denmark and there were always these trout ponds and you could sit there and catch trouts. This instantly reminds me of that.“). Some participants have also recognized some types of flowers that were present during the scenes and commented about them (e.g.: “The poppies, the water, all these are things that I love.“). Both blue spaces and the surrounding flora of a nature scene like poppies, could be components that are softly fascinating (Otten et al., 2022). The Attention Restoration Theory states, that soft fascination can be defined as stimuli that takes our attention in a non-demanding way, giving the opportunity to restore cognitive resources (Kaplan, 1995). Based on the aforementioned citations, the component compatibility could influence both valence and the level of memories and as such, further research can investigate whether the absence or presence of compatibility components (e.g. water, flowers) and their form (e.g. for water, whether it is a lake or a river) can stimulate actual conversations between older adults. (Otten et al., 2022).

At last, while not intended, this study has shown that brightness is also a variable that should be taken into account when creating virtual nature scenes. Based from the citations of the participants, it is implied that virtual nature scenes that have dim lightning or shadows generally receive more negative valence (e.g.: “I do not love the forests that much. I was always getting tired when being in forests. The air in the forest is heavy and the darkness that surrounds you. Here, I always

have to see, that I get to a place that is bright.“). Individuals also perceive more fear after darkness, which would align with the assumption that negative valence towards the scene with low mystery (hills absent) and low spaciousness (high tree density) could be due to low brightness (Hanyu, 1997). As such, further analysis on whether brightness could influence the valence and level of engagement should be conducted to see how brightness should be implemented or adjusted when creating virtual nature imagery.

4.5 Practical implications

This study has helped to continue to advance the discussion and research on how virtual nature scenes and their respective components mystery and spaciousness can affect the valence and level of engagement of the stories of older adults. As such, the findings can be used to further develop more beneficial virtual nature scenes by showing what stimuli can be positive or negative when aiming to encourage the participant to tell personally relevant memories. To continue, the study itself and the comments from the participants also gave possible ideas about what could be analysed in the future and whether other components might be worthwhile to investigate (e.g. soft fascination, compatibility and brightness).

To continue, the findings of this study and the future recommendations can give potential to use virtual nature scenes as a conversation starter between older adults as a form of intervention aimed at decreasing said loneliness. The results of this study show that scenes with high spaciousness (low tree density) and either high (hills present) or low (hills absent) mystery are generally liked more in comparison to other virtual nature scenes. While the results also show that valence does not correlate with the level of engagement, the study has shown that other virtual nature components like soft fascination and compatibility could be subject for more investigation and to see whether these components are generally liked and if the level of engagement of the stories is better than in comparison to mystery and spaciousness.

Even though the current results show, that virtual nature scenes still need adjustment and more research is needed to give potential to use them as a conversation starter, the future research recommendations and their implications can show, that virtual nature might be suitable as a psychological intervention in the form of starting conversation between older individuals when investigating the effect of other variables.

4.6 Conclusion

This study has shown, that there is no significant difference, when it comes to the manipulation of mystery and spaciousness in regards to the level of engagement the participants gave. Moreover, it is implied that scenes with low spaciousness and low mystery are rated significantly lower in comparison to scenes with low mystery and high spaciousness, as well as scenes with high mystery and high spaciousness. Future research could aim at investigating the manipulation of other nature related variables like soft fascination and compatibility as well as brightness. The results display, that while no scene results in greater level of engagement than the others, the citations from the interview show that other nature components like soft fascination and compatibility might be more suitable to use as material to start a conversation between older adults.

Reference List

- Alexandrakis, D. (2017). Reminiscence, Digital Storytelling and Maps: How Technology Affects Loneliness of Older Adults. In *Proceedings of 15th European Conference on Computer-Supported Cooperative Work-Doctoral Colloquium*. European Society for Socially Embedded Technologies (EUSSET).
- Anderson, C. (2010). Presenting and evaluating qualitative research. *American Journal of Pharmaceutical Education*, 74(8), 141. <https://doi.org/10.5688/aj7408141>
- Appel, L., Appel, E., Bogler, O., Wiseman, M., Cohen, L., Ein, N., Abrams, H. B., & Campos, J. L. (2020). Older adults with cognitive and/or physical impairments can benefit from immersive virtual reality experiences: A feasibility study. *Frontiers in Medicine*, 6. <https://doi.org/10.3389/fmed.2019.00329>
- Balyasnikova, N., & Gillard, S. (2018). " I Love to Write My Story": Storytelling and its role in seniors' language. *Canadian journal for the study of adult education*, 30(2).
- Banks, M. R., Willoughby, L. M., & Banks, W. A. (2008). Animal-assisted therapy and loneliness in nursing homes: Use of robotic versus Living Dogs. *Journal of the American Medical Directors Association*, 9(3), 173–177. <https://doi.org/10.1016/j.jamda.2007.11.007>
- Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, 44(10), 3947–3955. <https://doi.org/10.1021/es903183r>
- BMSLab. (2020). *Virtual Nature healing environment*. University of Twente.
Retrieved 24-8-2021 from <https://bmslab.utwente.nl/virtual-nature-healing-environment/>
- Cloutier-Fisher, D., Kobayashi, K., & Smith, A. (2011). The subjective dimension of social isolation: A qualitative investigation of older adults' experiences in small social support networks. *Journal of Aging Studies*, 25(4), 407–414. <https://doi.org/10.1016/j.jaging.2011.03.012>
- Coeterier, J. F. (1996). Dominant attributes in the perception and evaluation of the Dutch Landscape. *Landscape and Urban Planning*, 34(1), 27–44. [https://doi.org/10.1016/0169-2046\(95\)00204-9](https://doi.org/10.1016/0169-2046(95)00204-9)

- Compernelle, E. L., Finch, L. E., Hawkey, L. C., & Cagney, K. A. (2021). Momentary loneliness among older adults: Contextual differences and their moderation by gender and Race/Ethnicity. *Social Science & Medicine*, 285, 114307. <https://doi.org/10.1016/j.socscimed.2021.114307>
- Conner, K. O., Copeland, V. C., Grote, N. K., Koeske, G., Rosen, D., Reynolds, C. F., & Brown, C. (2010). Mental health treatment seeking among older adults with depression: The impact of stigma and Race. *The American Journal of Geriatric Psychiatry*, 18(6), 531–543. <https://doi.org/10.1097/jgp.0b013e3181cc0366>
- Cornwell, E. Y., & Waite, L. J. (2009). Measuring social isolation among older adults using multiple indicators from the NSHAP study. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 64B(Supplement 1), i38–i46. <https://doi.org/10.1093/geronb/gbp037>
- de Jong Gierveld, J., Keating, N., & Fast, J. E. (2015). Determinants of loneliness among older adults in Canada. *Canadian Journal on Aging / La Revue Canadienne Du Vieillissement*, 34(2), 125–136. <https://doi.org/10.1017/s0714980815000070>
- Freeman, C., Waters, D. L., Buttery, Y., & van Heezik, Y. (2019). The impacts of ageing on connection to nature: The varied responses of older adults. *Health & Place*, 56, 24–33. <https://doi.org/10.1016/j.healthplace.2019.01.010>
- Gallagher, T. (1977). Visual preference for alternative natural landscapes (PhD Dissertation). *Ann Arbor: University of Michigan*.
- Hanyu, K. (1997). Visual properties and affective appraisals in residential areas after dark. *Journal of Environmental Psychology*, 17(4), 301–315. <https://doi.org/10.1006/jevps.1997.0067>
- Herzog, T. R. (1987). A cognitive analysis of preference for natural environments: Mountains, canyons, and deserts. *Landscape Journal*, 6(2), 140–152. <https://doi.org/10.3368/lj.6.2.140>
- Ikemi, M. (2005). The effects of mystery on preference for residential facades. *Journal of environmental psychology*, 25(2), 167-173.
- Jansson, A. H., Muurinen, S., Savikko, N., Soini, H., Suominen, M. M., Kautiainen, H., & Pitkälä, K. H. (2017). Loneliness in nursing homes and assisted living facilities: Prevalence, associated factors and prognosis. *Journal of Nursing Home Research*, 3, 43-49.
- Jansson, A. H., Savikko, N., Kautiainen, H., Roitto, H.-M., & Pitkälä, K. H. (2020). Changes in prevalence of loneliness over time in institutional settings, and associated factors. *Ar*

chives of Gerontology and Geriatrics, 89, 104043. <https://doi.org/10.1016/>

j.archger.2020.104043

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of environmental psychology*, 15(3), 169-182.

Korpela, K., Borodulin, K., Neuvonen, M., Paronen, O., & Tyrväinen, L. (2014). Analyzing the mediators between nature-based outdoor recreation and emotional well-being. *Journal of Environmental Psychology*, 37, 1–7. <https://doi.org/10.1016/j.jenvp.2013.11.003>

Liszio, S., Graf, L., & Masuch, M. (2018). The relaxing effect of virtual nature: immersive technology provides relief in acute stress situations. *Annu. Rev. Cyberther. Telemed*, 16, 87-93.

Lundstedt, R., Håkansson, C., Löhmus, M., & Wallergård, M. (2021). Designing virtual natural environments for older adults in residential care facilities. *Technology and Disability*, 1–14. <https://doi.org/10.3233/tad-210344>

Lutz, W., Sanderson, W., & Scherbov, S. (2008). The coming acceleration of global population ageing. *Nature*, 451(7179), 716–719. <https://doi.org/10.1038/nature06516>

Marois, A., Charbonneau, B., Szolosi, A. M., & Watson, J. M. (2021). The differential impact of mystery in nature on attention: An oculometric study. *Frontiers in Psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.759616>

National Academies of Sciences, Engineering, and Medicine. (2020). *Social isolation and loneliness in older adults: Opportunities for the health care system*. National Academies Press.

Nukarinen, T., Istance, H. O., Rantala, J., Mäkelä, J., Korpela, K., Ronkainen, K., ... & Raisamo, R. (2020, April). Physiological and psychological restoration in matched real and virtual natural environments. In *Extended abstracts of the 2020 CHI conference on human factors in computing systems* (pp. 1-8).

Ong, A. D., Uchino, B. N., & Wethington, E. (2016). Loneliness and health in older adults: A Mini-Review and synthesis. *Gerontology*, 62(4), 443–449. <https://doi.org/10.1159/000441651>

Otten, K., Van Rompay T.J.L., Van 't Klooster, J.W.J.R., Gerritsen, D.L., & Westerhof, G.J. (2022). Can virtual nature provide associations that benefit conversations? A randomized factorial online survey to explore associations of older adults with virtual nature [Submitted for publication]. Department of Behavioral, Management and Social Science, University of Twente

- Peschardt, K. K., & Stigsdotter, U. K. (2013). Associations between park characteristics and perceived restorativeness of small public urban green spaces. *Landscape and Urban Planning, 112*, 26–39. <https://doi.org/10.1016/j.landurbplan.2012.12.013>
- Sugiyama, T., Thompson, C. W., & Alves, S. (2009). Associations between neighborhood open space attributes and quality of life for older people in Britain. *Environment and behavior, 41*(1), 3-21.
- van Houwelingen-Snippe, J., van Rompay, T. J. L., de Jong, M. D. T., & Allouch, S. B. (2020a). Does digital nature enhance social aspirations? An experimental study. *International journal of environmental research and public health, 17*(4), [1454]. <https://doi.org/10.3390/ijerph17041454>
- van Houwelingen-Snippe, J., van Rompay, T. J., & Ben Allouch, S. (2020b). Feeling connected after experiencing digital nature: A survey study. *International journal of environmental research and public health, 17*(18), 6879.
- Voutilainen, L., Henttonen, P., Kahri, M., Kivioja, M., Ravaja, N., Sams, M., & Peräkylä, A. (2014). Affective stance, ambivalence, and psychophysiological responses during conversational storytelling. *Journal of Pragmatics, 68*, 1–24. <https://doi.org/10.1016/j.pragma.2014.04.006>
- Westerhof, G., & Bohlmeijer, E. (2012). Life Stories and Mental Health:: The Role of Identification Processes in Theory and Interventions. *Narrative Matters, 2*(1), 106-128.
- World Health Organization. (n.d.). *Ageing and health*. World Health Organization. Retrieved January 28, 2022, from <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>
- Yeo, N. L., Elliott, L. R., Bethel, A., White, M. P., Dean, S. G., & Garside, R. (2019). Indoor nature interventions for health and wellbeing of older adults in residential settings: A systematic review. *The Gerontologist, 60*(3). <https://doi.org/10.1093/geront/gnz019>

Appendices

Appendix A

Information Sheet

"Virtual Nature" information sheet

Dear Participant.

Thank you for participating in the following experiment regarding virtual nature. This document is intended to help you get more information regarding participation in the study.

This study examines the impact of virtual nature and what experiences and memories can come up when looking at such scenes. The duration of this interview is between 30-40 minutes. Here, you will be shown various videos of virtual natural environments. After a short time, you will be asked questions about what memories and feelings you have when looking at the scene and what your personal story about these scenes are. The answers are examined with regard to emotions, feelings and memories and then statistically evaluated.

Participation may include small risks. Because personal memories can be evoked, there is a risk that the interview can become emotional. Furthermore, participation can exert you both physically and mentally. Finally, there is a risk of getting a COVID-19 infection in times of a pandemic. The project was examined by the BMS Ethics Committee and found to be ethically acceptable.

To counteract the risks, the study will follow the guidelines of the current COVID-19 policies and additional measures can be arranged to further reduce risks. To continue, while the interview can get emotional, you have full control over what you want to share with the researcher.

Participation may be withdrawn at any time without giving a reason. In this case, all records regarding the respective participation will be destroyed and all data will be deleted.

During the project, personal data is collected regarding experiences from the past, personal feelings and memories. The data that is collected will be stored on a Laptop and USB stick by means of an audio recording and will also be translated with software. The Laptop and the folder containing the

data (Recording, Translation...) are password-secured and the USB stick will be held in the private home of the researcher in an area, that can be locked up and that is only accessible to the researcher. The components are then statistically evaluated and all data is destroyed 90 days after the project has been concluded. In the event of a failure, the data will be destroyed 30 days after the second attempt has been graded again. Anonymous quotes and answers may be used and cited. These anonymous quotations could be reproduced literally in the bachelor thesis as well as in a doctoral thesis. Both bachelor thesis and doctoral thesis are open access and can be looked up by anybody. During the project, only the individual listed below can access the data.

Leroy Nickisch (l.nickisch@student.utwente.nl) S2054310

If you have questions about your rights, need more information, want to ask questions or want to discuss something, you can contact the Secretary of the Ethics Committee of the Faculty of Behavior, Management and Social Sciences of the University of Twente:

ethicscommittee-bms@utwente.nl

Appendix B

Interview Scheme

Author : Leroy Nickisch S2054310

Date :

Aim of interview from focus groups:

- Collect memories, emotions, feelings
- Research Question 1: Complex Data (Qualitative analysis Mystery and Spaciousness)
- Research Question 2: Correlation

Participants : 15-20

	What	Who
1	<p>Introduction</p> <ul style="list-style-type: none"> - introduce yourself - Student from University - 21 years old - Writing Bachelor Thesis - Psychology Department - Living in Gronau - (Sister working in residential facilities) - Purpose of this study - Analyzing effect of - virtual nature on starting real conversations - Collecting memories etc. based on scenes 	<ul style="list-style-type: none"> - Leroy - Participant - Before the interview (5 min.) - Information Sheet

2	<p>Informed consent</p> <ul style="list-style-type: none"> - Explaining procedure - Answer questions - Give Consent Form - Agreeing to record interview - Written Consent - Set Material up - Asking a last time about any questions 	<ul style="list-style-type: none"> - Leroy - Participant - Before the Interview (5 min.) - Informed consent form - Audio Recorder - Information Sheet
	<p>Start Audio Recorder</p> <ul style="list-style-type: none"> - Telling participant about starting - Mention Time, Date, Participant Number 	<ul style="list-style-type: none"> - Leroy - Participant - Beginning of Interview (2 min.) - Audio Recorder

3	Manipulation check <ul style="list-style-type: none">- Participant Number determines scenes- 2-3 scenes (4 if enough time)- Asking first question- „What is your first impression of this scene?“- Asking second question:- „Imagine you are at this place, what would you talk about?“	<ul style="list-style-type: none">- Leroy- Participant- During Interview (2-3 min.)- Laptop- Scenes / Data- Audio Recorder
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4	Collecting story <ul style="list-style-type: none">- Show Scene- Audio Recorder collects data- Collect enough data- Act according to content and length- Repeat for scene- Ask if there is still something they want to talk about	<ul style="list-style-type: none">- Leroy- Participant- Actual interview (5 min. per scene)- Laptop- Scenes- Audio Recorder- Other
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	<p>Stop Audio Recorder</p> <ul style="list-style-type: none">- Stop and Save	<ul style="list-style-type: none">- Leroy - Actual end of interview - Audio Recorder
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5	<p>Ending interview</p> <ul style="list-style-type: none"> - Questions - Opinion about Interview - Thank for participation - Explain procedure and what happens with data - Ask about consent again 	<ul style="list-style-type: none"> - Leroy - Participant - Time after interview (5 min.) - Informed Consent Paper - Information Sheet
Total duration interview 30-35 minutes		

Appendix C

Anonymization Concept

Anonymization Concept „Virtual Nature“

The following concept describes how the data that will be collected during the study „Virtual Nature“ is being anonymized and how participants can be sure that their personal answers and identity are being made unidentifiable.

- 1.) A separate file will be created where every participant will be given a number in order to make sure that the researcher knows which participant belongs to which recording. When one interview has been finished, the recording that is saved will be given a number as a name. The file where the participants name has been assigned a number is in a folder that is password-secured, separate from the other documents and only accessible to the researcher.
- 2.) The audio recording that will be made of every participant will be destroyed / deleted after it has been transcribed by the software. When transcribing, personal data such as names, place and other personal information that could lead to the identity of the participant will be anonymized (e.g when a participant mentions the year 2002 in a context, where it could lead to their identity, it will be anonymized into year XXXX. The same principle applies to all other information that could lead to their identity).
- 3.) At last, when using quotes or other parts of the participants answer, no names or other personal information will be used to identify the participant and their answer. Here, it will also be looked into whether some quotes could lead to the identity of the participant. A participant that mentions a very specific memory for example, that could lead to their identity when looking at the context and content, will not be used or made anonymized according to point 2.

Appendix D

Form for the participation

(YOU WILL RECEIVE A COPY OF THIS SHEET)

Tick the appropriate boxes.

Ye N
s o

Participation in the study.

I have read the available information regarding the study on (___ __ ___) or it was read to me. I was able to ask questions about the study and my questions were answered sufficiently.

I voluntarily agree to be a participant in this study and I understand that I can answer any question voluntarily and have the opportunity not to answer any questions. It is also possible to withdraw or cancel participation at any time without giving reasons.

I understand that participation in the study includes:

- An interview and an audio recording of this interview.
- The audio recording of the interview is converted into text with the help of a program.
- The audio recording is destroyed after ___ days.

Risks of the study.

I am aware that (or „I was informed that „) participation in the study may involve the following risks:

- Evoking negative experiences, memories, thoughts, emotions and feelings
- Physical and mental exertion
- The (small) probability of your identity becoming known
- Infection (COVID-19), minimal

Use of the information.

I understand that information I disclose will be used for the following:

- A bachelor thesis for the topic "Virtual Nature in relation to older individuals".
- The bachelor thesis could be part of a doctoral thesis of an employee of the University of Twente.
- Both bachelor thesis and doctoral thesis can be looked up online.
- All Data will be anonymized

I understand that personal information collected, such as name or place of residence, will not be disclosed outside the researcher.

I understand that my anonymized answers can be quoted.

Consent to the audio recording.

I agree that an audio recording of the study will be made.

I give permission that an audio recording of the data I give can be stored on a password-protected laptop and digital folder, as well as a USB stick. Evaluated data can be used for other research.

I give permission for an anonymous transcript of the audio recording to be made. No names are used or quotations from you that could lead to your identity.

Signature

Name of participant

Signature

Date

I have read the information to the participant and tried to explain the information in a comprehensible way in so far as the person can decide on what they agree to.

Study Director

Signature

Date

Contact details for further questions: Leroy Nickisch,
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