The Effect of Storytelling and Mysterious Nature on Loneliness

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Abstract

This study investigated the effect of storytelling and mysterious nature on loneliness in students. Loneliness is a prevalent problem in our society, especially in students. Storytelling has been suggested to decrease loneliness while mysterious nature has been connected to two loneliness decreasing factors, creativity and social connectedness. This study had a sample of 107 students from the University of Twente in the Netherlands. A 2 x 2 (mysterious nature high - low and writing task storytelling – neutral) design with a pre- and post-test of loneliness was employed. Experience of awe, social aspirations, degree of immersion and nationality were measured during the post-test as possible covariates. It was hypothesised that a storytelling writing task and mysterious nature would decrease loneliness significantly compared to their respective control condition and that there would be an interaction effect between the two variables. A significant decrease of loneliness was found in the whole sample, regardless of experimental condition. The main effects of storytelling and mystery were not significant. The interaction effect was significant, and the effects of mystery and storytelling seem to have a decreasing effect on each other. Social aspirations were confirmed as a covariate and was positively correlated with difference in loneliness scores. The findings suggest that exposure to a storytelling writing task and mysterious virtual nature might be able to decrease loneliness, and that storytelling and mystery should be best used separately. Both storytelling and mystery were more effective when used with the control condition of the other. This led to the assumption that for diminishing loneliness it is more effective to use either storytelling or mysterious virtual nature. The exact nature of the effects of storytelling and mysterious nature need to be examined further.

1. Introduction

Loneliness is a prevalent issue in today's society, especially in the current context of the covid-19 pandemic and comes with many health-related issues (Bu, Steptoe & Fancourt, 2020). A technique that has been related to decreased loneliness and improved mental wellbeing is the act of reminiscing through storytelling (Elias, Neville & Scott, 2015). Another potential way to decrease loneliness is exposure to nature which has been connected to improved mental health and restorative effects on the mind (Joey & Dewitte, 2018). Furthermore, it has been suggested that immersion (Liszio, Graf & Masuch, 2018) and the emotion of awe (Yaden, 2018) could influence the effect of nature, while the social aspirations someone has, appear to be crucial to their feelings of loneliness (Nicolaisen & Thorsen, 2017). At this moment in time, there is a gap in research concerning the effectiveness of storytelling, as well as the effect mysterious nature has on loneliness. Especially, a potential interaction effect of the two stimuli has not been investigated much yet. Thus, this study will further examine the effect of nature and storytelling on feelings of loneliness, as well as possible indirect effects of immersion, awe, and social aspirations, to gain more insight into how their influence works.

1.1 Loneliness

Loneliness typically emerges from a gap in the amount and quality of social interaction or communication that one needs and the amount and quality that one actually receives (Yuan et al., 2022). The unpleasant state of mind that results from this is what researchers describe as feeling lonely (Blazer, 2002; Yuan et al., 2022). Loneliness is associated with a number of psychological issues, such as: depression, social avoidance (Yuan et al, 2022) increased stress levels, anxiety, lower quality of sleep, feelings of hopelessness, rumination and even suicidal behaviour (Arslan et al., 2022). Therefore, looking at ways to decrease feelings of loneliness is an important step of improving wellbeing in general. The problem of loneliness has been pushed into the limelight as the covid-19 pandemic has exacerbated its prevalence (Koyama, 2021), but it has been a problem even before the start of the pandemic in 2020, with some groups being more at risk than others (Bu, Steptoe & Fancourt, 2020). Especially in students, feelings of loneliness have been on the rise, and they are now a population at risk of being severely lonely (Arslan et al., 2022).

Feeling lonely puts a lot of mental distress on a person and generally takes a toll on their mental health (Kessler et al., 2008). This presents a particularly serious problem as emotional stress and lack of a peer security system are related to the outbreak of severe mental health

disorders (Kessler et al., 2008). Many of these often develop during adolescence or early adulthood, such as depression (Barrocas, & Hankin, 2014). Hence, when looking at the high prevalence of loneliness in students and its possibly detrimental effects, a strong need for ways to decrease loneliness becomes evident.

1.3 Storytelling

The first variable that will be examined in this study is storytelling. Storytelling is the act of telling someone else about a personal memory or anecdote, so, sharing a story about something of personal valence that has happened in one's life (East et al., 2010). Talking about a memory can induce a state of reminiscing which has been associated with reduced feelings of loneliness and general improved mental wellbeing (Fujiwara et al., 2012). Especially the storytelling of a personal memory or anecdote has been suggested to be helpful. While sharing their story people are often reminded of positive experiences they have lived (Veldmeijer et al., 2020) and reported a heightened sense of belonging (Chiang et al, 2009). Thus, regular engagement in storytelling can be beneficial for mental wellbeing (Veldmeijer et al., 2020). Storytelling is also used in therapy and with the aim to improve said mental wellbeing by making people feel more integrated and heightening their sense of purpose in life (Veldmeijer et al., 2020). It has further been used to effectively reduce negative feelings, improve one's skills for coping with life problems, increase satisfaction with life, enhance self-integration (Chiang et al, 2009), achieve a greater admiration of oneself and actively keep in mind people that are important (Elias, Neville & Scott, 2015).

The study by Chiang et al (2009) found a significant positive effect of reminiscence therapy on loneliness in older adults. However, that study only included elderly male participants which raises questions about the generalisability of the findings. Yet another study by Veldmeijer et al (2020) investigated the effect of VR and storytelling in older adults and found that storytelling had a positive effect on loneliness. Thus, literature in general seems to suggest that storytelling, is beneficial for our mental health, as well as improving feelings of loneliness. However, it is not yet quite clear how strong this effect on loneliness is, as there are some mixed results as well. Tarugu et al (2019) examined the suitability of storytelling for reducing loneliness in a nursing home and found that loneliness did decrease but the effect was not significant. Hence the exact effect of storytelling on loneliness does not seem to be clear yet and more research into this topic is needed. Especially, the effect of storytelling on younger people needs to be examined, as most studies used elderly people as their sample. This study

will therefore focus on investigating the effect of reminiscing through storytelling in students. It is hypothesised that a personal storytelling writing task will significantly decrease feelings of loneliness (H1a) and that the storytelling writing task will have a greater negative effect on post loneliness scores than a neutral writing task (H1b).

1.2 Nature

Another potential way that could be beneficial for combating loneliness and the associated health issues, is exposure to nature. Research has associated being in nature with overall mental health benefits as well as restorative and relaxing qualities (Joye & Dewitte, 2018). However, so far literature has mostly associated exposure to nature with general improved wellbeing (Chiang, Li & Jane, 2017), and only a few studies have also investigated the effect of nature exposure on loneliness directly. For example, a study by Anderson (2019) found that connecting to nature could alleviate feelings of loneliness in older adults. A different study by Hammoud et al (2021) found that contact with nature was associated with lower levels of loneliness in participants and this effect remained true also when controlling for age, gender, or ethnicity. So, it seems that nature exposure is beneficial for people who feel lonely regardless of their background which makes it a suitable tool for fighting loneliness, as it can be universally used. However, it not quite clear yet how exactly the beneficial aspects of nature work and what aspects of nature reduce loneliness.

One theory that has been used to explain the restorative effects of nature exposure is the Attention Restoration Theory (ART) (Kaplan, 1995), which goes into detail about different aspects of nature and how they are advantageous for mental health. ART deals with people's wilful ability to concentrate and focus which, if depleted, can be restored by exposing them to nature scenes (Joye & Dewitte, 2018). According to ART nature is inherently fascinating which gives people something that they can focus on without having to make an effort. This allows our wilful attention reserves to replenish (Stevenson, Schilhab & Bentsen, 2018). ART proposes four main qualities that nature scenes possess which affect its restorative qualities: soft fascination (aspects of nature that softly capture attention, e.g. bodies of water), mystery (nature scenes that induce the sense that there is more to be discovered), spaciousness or vastness (grand nature like waterfalls or wide rolling fields), and compatibility (nature that gives the feeling that it is fitting to what a person is trying to use it for, e.g. a little trail that one can follow on a walk). It is not completely clear yet which aspects of nature have which specific impact, but mystery could be the most suited nature characteristic for this study. A feeling of mystery is

usually induced by the sense that there is something more to explore or something more that is awaiting, should one go further into the scene (Kaplan & Kaplan, 1989). This is often induced by objects that obscure features of the scene, such as hills in the distance or meandering trails, which give the impression that there is more to be seen and discovered.

Mystery has been connected to social connectedness and storytelling (Otten et al., 2022) and creativity (van Rompay & Jol, 2016) which have been connected to reduced loneliness, as explained below. A so far unpublished study by Otten et al. (2022) investigated how different aspects of nature influenced the participant's associations with it and the suitability of these associations for starting social contact. They found that mystery induced the highest amount of personally relevant and positive associations and was thus, suitable for increasing feelings of social connection. This is interesting as, Jose and Lim (2014) found a connection between social connectedness and loneliness. Further, Lim and Gleeson (2014) state that feeling disconnected is often a part of feeling lonely. Accordingly, if mystery is able to induce enhanced feelings of connectedness, this might be advantageous for decreasing feelings of loneliness as well. Additionally, the results of Otten et al (2022) suggest a connection between mystery and storytelling as well. Nature has been suggested to be able to induce storytelling (Hendricks et al, 2016) and Otten et al (2022) found that participants experienced the most personally relevant reflective associations in nature that had a high degree of mystery. The nature higher in mystery might, consequently, make it easier for participants to recall personally relevant memories for storytelling. The results of Otten et al (2022) underline the assumption that mystery would be the most beneficial nature characteristic for the current study. Further, van Rompay and Jol (2016) found that mysterious nature can strengthen our creativity and Mahon et al (1996) have suggested a negative correlation between creativity and loneliness, meaning that higher creativity predicts lower loneliness. Henceforth, if mystery promotes feelings of social connectedness and creativity which have been connected to a decrease in loneliness, it might be beneficial for reducing loneliness too.

To explore this effect further, this study will manipulate the degree of mystery in nature scenes to investigate the effect of mysterious nature on loneliness. It is expected that exposure to nature scenes high in mystery will significantly decrease feelings of loneliness (H2A) and that a mysterious nature video will have greater negative effect on loneliness than a non-mysterious nature video (H2b). As both storytelling and mystery are expected to reduce loneliness and mysterious nature has been connected to inducing storytelling, this study assumes that combining storytelling and mystery would have an even greater effect. Hence, it

is expected that a combination of exposure to a mysterious nature scene and a personal writing task will have a greater effect of decreased feelings of loneliness compared to exposure to a different combination (H3).

1.2.1 Virtual Nature and Immersion

Going into nature whenever you feel lonely might not always be a realistic option, for example for people who live in the centre of big cities or have mobility constraints (White et al., 2018). Virtual nature has been suggested as an alternative to real nature, and many studies have reported positive effects of exposure to virtual nature on relaxation level (Anderson et al., 2017) and mental health (Yu et al, 2018). Further, a literature review by Frost et al (2022) found that virtual nature could decrease negative affect. One study by Valtchanov, Barton and Ellard (2010) even found that virtual nature has comparable effects to real nature and might therefore be used as a substitute. Virtual nature refers to nature that is experienced through the means of technology, such as screens or VR goggles (White et al., 2018). Additionally, virtual nature is easier to manipulate in terms of including the characteristics that were suggested to induce a sense of mystery in the viewer. Hence, this study will use virtual nature for measuring the effect of mystery. The effect of virtual nature has been connected to feelings of immersion. In a study by Liszio et al (2018) high immersion scores predicted lower anxiety levels. Yeo et al (2020) also found that higher immersion mediated higher enhancement of positive affect. This suggests that virtual nature could be more efficient for participants who feel more immersed into the scene. This study therefore will also measure the degree of immersion into the virtual nature scene, to explore the relationship between degree of immersion, loneliness scores and mysterious nature.

1.2.2 Awe

Awe describes the experience of perceiving something so vast that one needs to reappraise their own mental schemas to deal with the experience (Gottlieb et al., 2018) and consists of several different facets (Yaden et al., 2018). Among others vastness, self-diminishment and connectedness were found to be features of experiencing awe (Yaden et al., 2018). Awe has often been connected to experiencing nature. Awe has been suggested to be able to buffer negative emotions (Powell et al., 2011). Further, feeling awe might enhance our connection to nature as well (Powell et al., 2011) and improve our wellbeing (Yaden et al., 2018). Experiencing beautiful nature can induce positive feelings and awe experience in general has been reported to lead to a revaluation of one's situation (Powell et al., 2011). People felt

more relaxed and were able to look at their worries from a more reflected point of view (Powell et al., 2011). Lastly, awe has connected to perceiving a shift away from oneself and more towards experiencing a collective self (Shiota et al., 2005). This might interact with feelings of loneliness, as people who are lonely often perceive a disconnect between themselves and others (Lim & Gleeson, 2014) and a collective self might make them feel more connected. Thus, the relationship between awe, feelings of loneliness and virtual nature will be investigated.

1.2.3 Social Aspirations

A study by van Houwelingen-Snippe et al. (2020) found that virtual nature can induce social aspirations in young adults. These findings were replicated in a later study with older adults, who also reported heightened social aspirations after experiencing virtual nature (van Houwellingen-Snippe et al., 2022). This is interesting when studying loneliness as Nicolaisen and Thorsen (2017) found that having social aspirations is more influential on feelings of loneliness than the actual social contact a person has. This is especially important in the context of this study, as they also found that young adults are the age group that have greater social aspirations and expectations than other age groups. Feelings of loneliness emerge from a difference in desired and actual contact (Yuan et al., 2022), so if young people are more prone to having higher expectations or social aspirations, both of which seem to influence loneliness (Nicolaisen & Thorsen, 2017), that might interfere with measuring the impact of mysterious nature. Hence, the current study will examine the relationship between social aspirations, loneliness and virtual nature for this study.

1.4 Hypotheses

Literature shows that loneliness is a prevalent problem, especially in young adults, such as students, where feelings of loneliness are rising. Two things that have been proposed to reduce feelings of loneliness are exposure to nature scenes, especially ones that are high in mystery, and storytelling. However, the effect of these two variables is not completely clear yet and thus, needs to be investigated further. This leads to the research question: How Do a Storytelling Writing Task and Mysterious Nature Decrease Loneliness in Students? The following hypotheses have been conceptualised to answer this question:

H1a: A storytelling writing task will significantly decrease feelings of loneliness.

H1b: A storytelling writing task will reduce feelings of loneliness more than a neutral writing

task.

H2a: Exposure to nature scenes high in mystery will significantly decrease feelings of

loneliness.

H2b: A mysterious nature video will reduce feelings of loneliness more than a non-mysterious

nature video.

H3: A combination of exposure to a mysterious nature scene and a personal writing task will

have a greater effect of decreased feelings of loneliness compared to exposure to a

different combination.

Further, immersion, social aspirations, and emotion of awe will be explored as covariates.

2. Methods

2.1 Study design

This study consisted of a two-by-two design with a pre- and post-measurement. The main independent variables were degree of mystery with two levels, high and low mysteriousness, and storytelling, also with two levels, personal storytelling, and neutral storytelling. This means that there were four conditions: a high mystery and personal storytelling, a low mystery and personal storytelling, a high mystery and neutral storytelling, and a low mystery and neutral storytelling condition as the control group. The experiment was set up like this so that the effect of nature high in mystery and personal storytelling on loneliness separately, as well as their interaction effect could be measured. Testing loneliness twice ensured that its degree could be compared to see how big the effect of mysterious nature and personal storytelling was. The control group (low mystery and neutral storytelling) was added, so that if an effect is observed, it could be ruled out that this effect was simply due to people reporting to be less lonely the second time they filled out the questionnaire. So, in the end the effect of mysterious nature, personal storytelling and their interaction effect was measured. Awe, social aspirations, and immersion were added as covariates.

2.2 Stimuli

The nature videos were developed using the software Virtual Nature which was provided by the BMS lap of the University of Twente. 8 mysterious scenes were developed. To induce a sense of mysteriousness winding pathways, shadows, hills, and tree's that partially hide the background were included (Figure 1), as these features have been connected to

mysteriousness (van Rompay & Jol, 2016). 6 non-mysterious natures scenes were constructed in contrast to that and thus, featured less trees, no hills or pathways and no part of the environment was hidden from view (Figure 2). The nature scenes are short videos of one minute. In order to facilitate immersion into the scene a soundtrack of birdsong was included. The soundtrack was the same for both videos to ensure that it would not affect the results. The nature scenes in the videos also had some movement of the trees and gras, to give the effect of a gust of wind passing over the scene, to facilitate immersion.

Figure 1

Screenshot of the Mysterious Virtual Nature Scene

Figure 2

Screenshot of the Non-mysterious Nature Scene

All 14 scenes that were developed were subsequently pilot tested for their degree of mysteriousness. Participants of the pilot test (N = 10) were shown all 14 videos, in case one of the non-mysterious nature videos somehow elicited more feelings of mystery than the mysterious nature scenes. Then participants were asked to rank the videos according to their degree of mystery. Participants ranked the videos by placing them in an order where the first video was the one they thought was the most mysterious and 14 was the video they found the least mysterious. This way each participant of the pilot test assigned each video a number from 1 to 14. Then for each video the scores of all 10 participants were added up and the one with the lowest score was chosen as the mysterious video and the one with the highest score was chosen as the non-mysterious video. Video 3 had a lowest rank score with 21 and video 9 the highest with 120, and were consequently the chosen for this study (Appendix 1).

The storytelling stimuli consisted of tasks where the participants had to describe a memory. In the experimental storytelling condition, the emphasis was on a personally important memory. Thus, a writing task where participants had to describe a personally important memory in detail was chosen as the storytelling stimulus. Participants were asked to describe their memory in detail and a few cues for what to include were given. To invite participants to take their time to think about the task a time frame of five minutes was suggested. The stimulus was worded as follows:

"Now, please try to remember an event that has been meaningful or important to you, it can be anything. Describe it in the text box below in as much detail as possible. For example, try to remember what happened, where it happened, who was with you, what you felt in that moment and why it is important to you. After 5 minutes you can go on to the next question but feel free to take your time."

For the neutral storytelling stimulus, a writing task about what the participants had eaten the day before was chosen, as this memory likely held not a lot of personal importance. To ensure that participants put in a similar amount of effort in the neutral task as in the storytelling task, a focus was set on recalling all included ingredients. The stimulus for the neutral writing task was worded like this:

"Now, please try to remember what you ate during the whole day yesterday. Tell us about it in the text box below, be as detailed as possible about the ingredients. After 5 minutes you can go on to the next question but feel free to take your time.

2.3 Participants

The study was carried out in April 2021 with 107 students from the University of Twente in the Netherlands and was granted ethical approval by the ethics committee of the of the Behavioural, Management and Social Sciences Faculty. Only students who were older than 18, proficient in the English language and did not have any severe visual impairments, were able to participate. No participants had to be excluded form data analysis, as all of them met the inclusion criteria. Thus, the final simple consisted of 107 participants. Overall, 57 (53.3%) of the participants were female, 49 (45.8%) male and 1 participant (0.9%) selected other when asked about their gender. The participants were between 18 and 30 years old ($M=22.04$, $SD:2.12$). 65 (60.7%) participants gave German as their nationality, 15 (14%) Dutch and 27 (25.2%) indicated a different country of origin. The mystery condition had 48 participants, the non-mystery 59, the personal storytelling task 56, and the food description task condition 51. No significant differences for age between the two groups of nature videos ($T(105) = 0.94$, $p = .352$) or writing tasks ($T(105) = 0.54$, $p = .592$) were found. For gender no significant differences between mystery ($X^2 (2, N = 107) = 0.92$, $p = .631$) or writing task ($X^2 (2, N = 107) = 1.3$ $p = .523$) conditions were found either. For the writing task condition, no significant difference was found for nationality ($X^2 (2, N = 107) = 0.72$, $p = .699$). However, there was a significant difference of nationality between the mystery and non-mystery condition ($X^2 (2, N = 107) = 11.47$, $p = .003$) (Table 2).

Table 1

Demographics of the study sample

Variables	Mystery		Non-Mystery		Personal Storytelling		Neutral Storytelling		Total	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Participants	48	44.86	59	55.14	56	52.34	51	47.66	107	100
Gender										
Female	25	52.1	32	54.2	28	50.0	29	56.9	57	53.3
Male	23	47.9	26	44.1	27	48.2	22	43.1	49	45.8
Other	0	0	1	1.7	1	1.8	0	0	1	0.9
Age (Years)[a]	22.25	2.4	21.86	1.93	22.14	2.46	21.92	1.71	22.04	2.12
Nationality										
German	26	54.2	39	66.1	32	57.1	33	64.7	65	60.7

Dutch	3	6.3	12	20.3	9	16.1	6	11.8	15	14.0
Other	19	39.6	8	13.6	15	26.8	12	23.5	27	25.2

a Age is presented in mean age and standard deviation

Table 2

Check for significant differences between conditions for age, gender, and nationality

	Nature videos	Writing tasks
Age	$T(105) = 0.94, p = .352$	$T(105) = 0.54, p = .592$
Gender	$X^2 (2, N = 107) = 0.92, p = .631$	$X^2 (2, N = 107) = 1.3\ p = .523$
Nationality	$X^2 (2, N = 107) = 11.47, p = .003$	$X^2 (2, N = 107) = 0.72, p = .699$

2.4 Procedure

The participants signed up for the study via the SONA system of the University of Twente. Upon arrival, participants were welcomed, shown to the room, briefed on the procedure and conditions of the study. It was pointed out that they would encounter a video of a virtual nature scene, for which they should put on the headphones. If they had no questions the participants were then left instructed to start the survey and were left alone in the room. They completed the study by filling out a Qualtrics survey which randomly allocated the participants to one of the four (high mystery – personal storytelling, low mystery – personal storytelling, high mystery – neutral storytelling, low mystery – neutral storytelling). The first page included some general information about the study and their rights as a participant again, as well as the question whether they consented to participate in the study. Next, some general demographic questions about their age, gender and nationality are asked. Participants then filled out the questions regarding loneliness, after which they watch the short virtual nature video. To ensure as much immersion as possible, participants were instructed to watch the video in full screen mode and received a few instructions on how to immerse themselves into the scene. Next, the participants completed the short storytelling task. Then the level of loneliness was measured again with the same questionnaire. Next, their feelings of awe and social aspirations and their degree of immersion into the nature scene were assessed. After participants have completed the survey, they were given the chance to write down their email address if they wanted to participate in a raffle to win a take-away voucher. This was done to give people an incentive to participate and to thank those who participated.

2.5 Measurements

2.5.1 Loneliness Scale

Loneliness is measured with a combination of a short version of the UCLA Loneliness Scale, called the ULS-6 and some items that were constructed for this study. The USL-6 has shown satisfactory psychometric qualities, similar to those observed with the full version of the UCLA Loneliness Scale. The ULS-6 measures the concept of loneliness as unidimensional and uses the definition of loneliness as a difference in "desired and actual social contact" (Neto, 2014) which is in line with the definition that was chosen for this study. The outcomes of the UCLA Loneliness Scale and the ULS-6 correlated significantly. Structure validity, internal consistency reliability and criterion-related validity are all sufficient as well. This scale has also mainly been tested with young adults which is also fitting for this study (Neto, 2014). As the name suggests, the scale consists of six items (e.g., "I lack companionship") which are assessed using a four-point Likert scale. Six additional items were added; items 8, 11 and 12 were taken from the UCLA-Loneliness Scale (McWhirter, 1990), and items 7, 9 and 10 were newly constructed. Hence, the full loneliness scale that was constructed for this study was 12 items long. The new items were formulated positively as most of the USL-6 items were formulated negatively, to make sure participants would stay attentive when filling out the questionnaire. Item 7 "I am fine being on my own." was constructed to measure to what degree participants enjoyed the time they spent alone and were happy to be alone. People who feel very lonely would likely not enjoy being alone. Item 8 "There is someone who understands me." was constructed from the UCLA item "There are people who really understand me." and was chosen to assess whether participants had close friends. The study by (Nicolaisen & Thorsen, 2017) found that not having close friends was an important indicator of loneliness. Item 9 "I am at peace with the nature of my social relations" and item 10 "I feel that there are enough people around me." were created to measure how satisfied someone is with the quality and quantity of their current social life. A crucial sign of being lonely is feeling a discrepancy between what one wishes their social life to be and what it actually is (Blazer, 2002). Item 11 "I feel in tune with the people around me." and item 12 "I have things in common with the people around me.", constructed from the UCLA item "I have a lot in common with the people around me", estimates how much people feel connected to their peers, as feeling disconnected is often part of feeling lonely (Lim & Gleeson, 2014).

To test the validity of the current 12-item scale a factor analysis was conducted, using a cut-off point of 0.4 for significant factor loadings (Yaden et al., 2018). In this study, all items of this loneliness scale loaded significantly except for item 6 "I am fine being on my own." (Appendix 4), which had a factor loading of .38 and was thus excluded from further analyses. The Cronbach's alpha for the remaining 11 items was .87 and the scale was thus found to be highly reliable (Vorderer et al., 2004). The loneliness scale (Appendix 5) is assessed using a four-point Likert scale (never, rarely, sometimes, often). For analysing the results, mean scores were calculated of the pre and post measurement. The mean difference between the pre and post loneliness scores was computed by subtracting post loneliness scores from pre loneliness scores.

2.5.2 Social Aspirations Scale

To measure social aspirations the Social Aspirations Scale was used, which assesses how suitable participants find the viewed virtual nature scene for meeting other people ("I would like to show this landscape to someone") and showed high reliability with a Cronbach's alpha of 0.74 in a similar study (van Houwelingen-Snippe et al., 2020). It is assessed with a 5-point Likert scale (strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree) and consists of five items (Appendix 6) which all loaded significantly (Appendix 4). The Cronbach's alpha for this study was .63 which indicates that the scale is moderately reliable (Katz et al., 2007). To analyse the results, mean social aspirations scores were calculated.

2.5.3 Experience of Awe scale

For measuring awe, the awe experience scale was used. This scale consists of six subscales, of which three were used in this study: diminished sense of self, connectedness, and perceived vastness. Diminished sense of self measures to what extent participants experience a smaller self, either psychologically or physically ("I felt my sense of self shrink"). Connectedness assess how much participants feel united with the nature scene they saw ("I felt closely connected to humanity"), and vastness evaluates how much the nature scene induced a sense of something profound and great in them ("I experienced something greater than myself") (Yaden et al., 2018). Reliability of the subscales are high as Cronbach's alpha was above 0.8 for each of them (Yaden et al., 2018). The awe experience scale is measured with a 7-point Likert scale (strongly disagree, moderately disagree, somewhat disagree, neither agree nor disagree, somewhat agree, moderately agree, strongly agree) and consists of 15 items. The

factor analysis revealed two underlying factors (Appendix 4), one for diminished sense of self and one for connectedness and vastness. The study that created the experience of awe scale found a different factor for each subscale (Yaden et al., 2018), so having more than one factor is not a concern for validity. To assess the experience of awe of the participants a mean awe score of all 15 items was computed. Cronbach's alpha was .90 for this study which indicates high reliability (Yaden et al., 2018). The full list of items can be found in Appendix 7.

2.5.4 Immersion Scale

Lastly, to measure immersion a subscale of the MEC Spatial Presence Questionnaire, namely the 4-item Spatial Presence one, was used. It assesses the degree to which participants felt part of the nature scene ("I felt like I was actually there in the environment of the presentation") (Appendix 8). The Cronbach's alpha of this subscale was 0.92 which indicates high reliability (Vorderer et al., 2004). However, the Cronbach's alpha of this study was .91 which indicates high reliability (Vorderer et al, 2004). All items loaded significantly on one factor (Appendix 4). It is measured using a 5-point Likert scale (strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, strongly agree) and was analysed using the mean score of all items.

2.6 Data analysis

The data gathered in this study was analysed using the statistics software SPSS. At first, factor analyses were performed, and Cronbach's alpha was calculated to check the validity and reliability of the scales that were used for this research within the current sample. Next, the demographics were assessed with the frequencies function of SPSS. Means and standard deviations of all variables were calculated for the whole sample and the four groups with a one-way ANOVA. Next, it was assessed whether the participants in the *mysterious nature / storytelling writing task* differed significantly from those in the *non-mysterious nature / neutral writing task* condition, regarding their age, gender or nationality. To assess significant differences of age, an independent samples *t*-test was used with the variable *age* and the *nature video* (mysteriousness – non-mysteriousness) / *writing task* (storytelling – neutral) dummy variable respectively. To determine possible significant differences of *gender*, a chi-square test was executed with the variables *gender* and the dummy variable of *nature video / writing task*. Another chi-square test was used to check for significant differences in *nationality*, using the *nationality* variable and the *nature video / writing task* dummy variable respectively.

To assess whether hypothesis 1a ("A storytelling writing task will significantly decrease feelings of loneliness.") is true, the pre and post loneliness scores of the storytelling writing task condition were assessed for significant differences. A paired samples *t*-test was conducted using the variables *mean pre loneliness* and *mean post loneliness*. To make sure that SPSS would compare the storytelling writing task and the neutral writing task conditions, the data was grouped using the dummy variable *writing task* (storytelling – neutral).

Hypothesis 2a ("Exposure to nature scenes high in mystery will significantly decrease feelings of loneliness.") was also tested with a paired samples *t*-test, using the variables *mean pre loneliness* and *mean post loneliness*. To make sure that SPSS would compare the mysterious and non-mysterious conditions, the data was grouped using the *nature video* dummy variable (mysteriousness – non-mysteriousness). This way it was possible to determine whether pre and post loneliness scores differed significantly in the mysteriousness condition.

To test hypothesis 1b ("A storytelling writing task will reduce feelings of loneliness more than a neutral writing task."), hypothesis 2b ("A mysterious nature video will reduce feelings of loneliness more than a non-mysterious nature video.") and hypothesis 3 ("A combination of exposure to a mysterious nature scene and a personal writing task will have a greater effect of decreased feelings of loneliness compared to exposure to a different combination.") a General Linear Model (from here on referred to as General Linear Model[a]) with a repeated measures design was conducted. The variables *mean pre loneliness* and *mean post loneliness* were used as within subject variables, and the dummy variables for *nature video* and *writing task* as the between subject factors. It was examined whether the differences between pre and post loneliness scores differed significantly, between the storytelling and the neutral writing task condition (H1b) and between the mysterious and the non-mysterious nature video condition (H2b). To test hypothesis 3, the interaction effect of nature video and writing task was examined.

Lastly, the previous analysis was repeated with *immersion*, *emotion of awe* and *social aspirations*, as well as *nationality* as covariates. *Nationality* was added since there were significant differences in the distribution of participants' nationalities between the mysterious and the non-mysteriousness condition. The General Linear Model with the covariates will from here on be referred to as General Linear Model[b].

Two additional analyses were performed to further examine the variables *immersion*, *awe* and *social aspirations*. First, an independent samples t-test was carried out with *immersion*,

awe and *social aspirations* and the *mysterious dummy* variable as a grouping variable to check for significant differences in *immersion*, *awe* and *social aspirations* between the two *virtual nature* conditions. Secondly, a correlation analysis was performed with the variables *social aspirations* and *difference in loneliness score*, to take a closer look at their relationship.

3. Results

3.1 Descriptive Statistics

Mean loneliness scores ranged from 1.77 to 1.97 in the pre-measurement conditions and 1.74 to 1.91 in the post-measurement. The average degree of loneliness was thus, quite low as the possible scores range from 1 to 5. Further, loneliness scores decreased in all conditions, with the highest decrease in the mysteriousness condition. Mean awe scores were highest in the non-mysterious condition. For social aspirations, participants reported the highest scores in the mysteriousness condition. Participants reported the highest degrees of immersion in the neutral writing task condition (Table 3).

Table 3

Means and standard deviations of pre- and post- loneliness, the difference in loneliness scores, social aspirations, awe and immersion

Variable	Mysteriousness		Non-mysteriousness		Storytelling		Neutral		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre-loneliness	1.97	0.53	1.77	0.43	1.90	0.44	1.81	0.52	1.86	0.48
Post-loneliness	1.91	0.53	1.74	0.45	1.86	0.45	1.76	0.52	1.81	0.49
Loneliness difference	0.07	0.18	0.04	0.20	0.05	0.19	0.06	0.20	0.05	1.10
Social aspirations	3.95	0.63	3.77	0.70	3.83	0.69	3.87	0.67	3.85	0.68
Awe	4.16	1.03	4.29	0.97	4.18	0.96	4.29	1.04	4.23	0.99
Immersion	3.32	0.91	3.21	1.05	3.09	1.00	3.44	0.95	3.26	0.99

3. 2 Main findings

Overall, loneliness scores decreased significantly ($F(1, 1) = 9,458, p = .003$) from the pre measurement ($M = 1.86, SD = 0.48$) to the post measurement ($M = 1.81, SD = 0.49$) in the sample. However, hypothesis 1a had to be rejected. The paired samples t-test did not show a

significant decrease in loneliness scores from pre (M = 1.90, SD = 0.44) to post measurements (M = 1.86, SD = 0.45) in the storytelling task condition (t(55) = 1.83, p = .072). The General Linear Model[a] also showed no significant difference in the decrease in loneliness scores in the storytelling writing task (M = 0.05, SD = 0.19) compared to the neutral writing task (**M** = 0.06, SD = 0.20) (F(1, 1) = .313, p = .577), so hypothesis 1b has to be rejected as well. Hence, a main effect of storytelling was not found.

Hypothesis 2a can be accepted. Loneliness scores did decrease significantly in the paired samples t-test from the pre (M = 1.97, SD = 0.53) to the post measurement (M = 1.91, SD = 0.53) for the mysteriousness condition (t(47) = 2.58, p = .013). However, in the General Linear Model[a], no main effect of mystery was found (F(1, 1) = 1.038, p = .311), as the difference in loneliness scores did not differ significantly between the mysterious nature video (M = 0.07, SD = 0.18) and the non-mysterious nature video (M = 0.04, SD = 0.20). Hence, hypothesis 2b had to be rejected as well.

The interaction effect in the General Linear Model[a] between mysterious nature and storytelling was significant (F(1, 1) = 4.607, p = .034) and hypothesis 3 could be accepted. However, contrary to prior expectations, a combination of storytelling and mystery did not show the biggest decrease in loneliness scores (M = 0.03, SD = 0.18). Instead, they showed a lower difference in loneliness scores for a combination of storytelling and mystery than for the combinations of storytelling and non-mysteriousness (M= 0.07, SD = 0.20) and mysteriousness and a neutral writing task (M = 0.13, SD = 0.17). The biggest difference in loneliness scores occurred in fact, in the mystery and neutral writing condition (M = 0.13, SD = 0.17), as evident from Table 5 and Figure 3. Hypothesis 3 thus had to be rejected.

Figure 3

Profile Plot of Mean Difference in Loneliness Scores in the Experimental Conditions
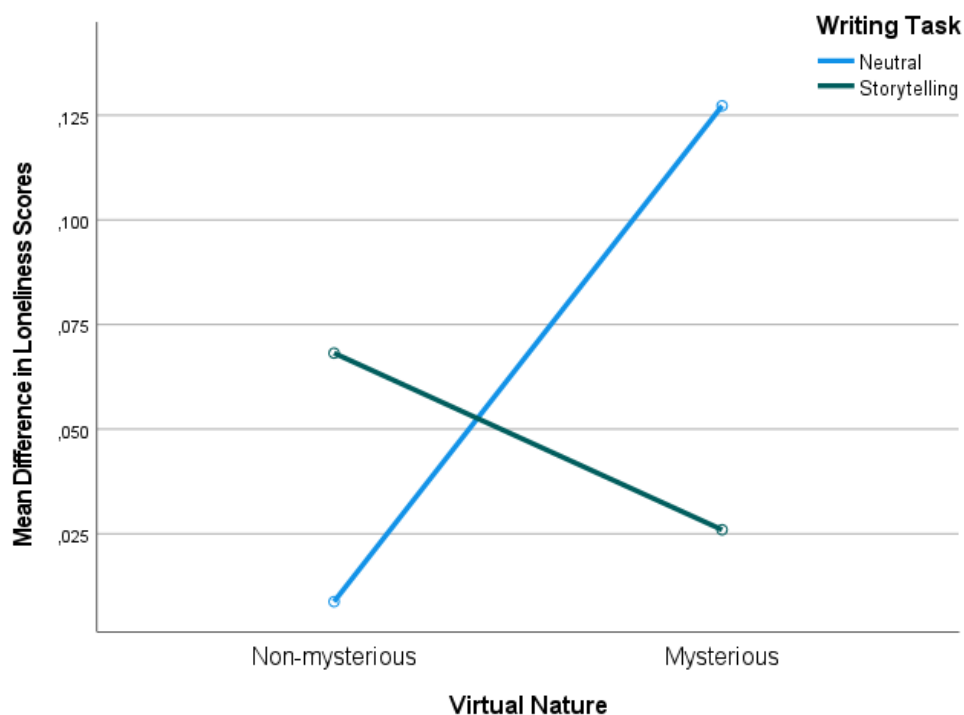
Table 5

Mean difference in loneliness scores for the experimental conditions

Experimental condition		Difference in loneliness scores	
Mystery	Writing task	M	SD
High	Storytelling	0.03	0.18
	Neutral	0.13	0.17
Low	Storytelling	0.07	0.20
	Neutral	0.01	0.20

Lastly, adding social aspirations, awe, immersion and nationality to the model as covariates, did not change the main effects of storytelling writing task ($F(1, 1) = 0.44$, $p = .835$) and mysterious nature video ($F(1, 1) = .225$, $p = .636$) which remained not significant, or the interaction effect which stayed significant ($F(1, 1) = 4.620$, $p = .034$). However, it did change the effect of the decrease in loneliness from pre-measurement scores ($M = 1.86$, $SD = 0.48$) to post-measurement ($M = 1.81$, $SD = 0.49$) in the complete sample which was not significant anymore ($F(1, 1) = 2.907$, $p = .091$). Of the three covariates only social aspirations was significant ($F(1, 1) = 4.622$, $p = .034$). Awe ($F(1, 1) = .696$, $p = .406$), immersion ($F(1, 1) = 2.158$, $p = .145$) and nationality ($F(1, 1) = 0.52$, $p = .082$) were not significant.

The t-test, to check for significant differences in immersion ($t(105) = 0.56$, p = .578), awe ($t(105) = -0.66$, $p = .511$) and social aspirations ($t(105) = 1.32$, $p = .189$) between the two virtual nature conditions, was not significant (Table 6).

Table 6

t-test of immersion, awe, and social aspiration in the virtual nature condition

	t-value	df	p-value
Immersion	0.56	105	.578
Awe	-0.66	105	.511
Social aspirations	1.32	105	.189

To further explore the relationship between social aspirations and difference in loneliness scores, a correlation analysis was conducted. It revealed that social aspirations is a significant predictor of differences in loneliness scores ($r(105) = 0.23$ $p = .019$). As evident in Figure 4 and Table 6, which displays the relationship between social aspirations and loneliness, higher social aspirations correlated with higher differences in loneliness scores.

Figure 4

Relationship of the Covariate Social aspirations and Differences in Loneliness Scores
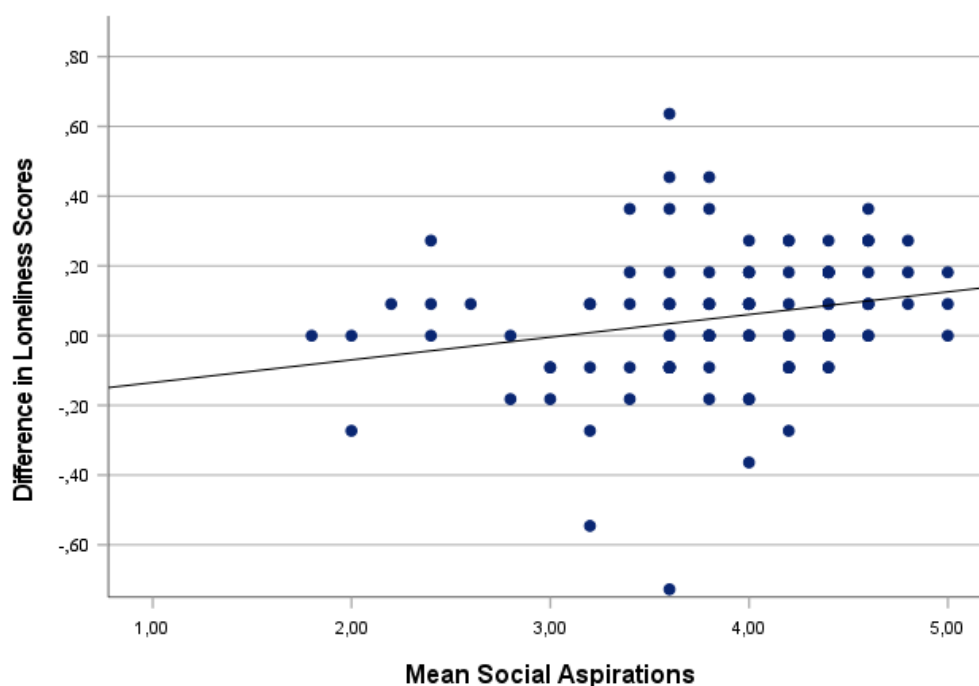
5. Discussion

This study aimed at investigating the effect of virtual mysterious nature and storytelling on feelings of loneliness in students. Social aspirations, experience of awe, degree of immersion and nationality as possible covariates were assessed as well. In general loneliness

scores were quite low from the start. Results indicate that the sample of the current study rarely experienced feelings of loneliness. Nevertheless, loneliness decreased significantly in the whole sample.

It was hypothesised that a personal storytelling writing task would significantly reduce loneliness in participants (H1a) and that the effect of a personal storytelling task would be greater than a neutral writing task (H1b). This expectation was not met as participants did not report a significant decrease in their feelings of loneliness, nor did the amount that loneliness reduced differ significantly between the two writing tasks. This finding goes against prior expectations, as the study by Veldmeijer et al (2020) suggested a positive effect of storytelling on loneliness and Chiang et al (2009) found significant decreases in feelings of loneliness in their participants as well. This poses the question as to why the current study did not find a main effect of storytelling. First, it has to be noted that the set-up of the current study differed greatly form that of Veldmeijer et al (2020) and Chiang et al (2009). Both studies implemented storytelling over an extended period of time and had multiple sessions in which their participants took part in. Next, both studies had a sample that consisted entirely of older adults who had reported being lonely. This poses two significant differences to the current study, whose sample consisted entirely of students between the age of 18 and 30 and who reported rather low loneliness scores to begin with. So, the person's background and previous intensity of feelings of loneliness might play a role in how storytelling works. The next big difference is that both the study by Veldmeijer et al (2020), as well as by Chiang et al (2009), implemented storytelling in a group setting, whereas the current study asked participants to tell their story by themselves. Thus, they had no opportunity to bond with someone over their story. Veldmeijer et al (2020) suggested that the social activity that came with telling others your story might have significantly aided in reducing loneliness. Chiang et al (2009) also note that their intervention provided an opportunity for social interaction, which facilitated feelings of belonging to a group and forming new friendships. So, the results from these two studies suggest that storytelling should be implemented in a group setting for it to work. Lastly, the studies by Veldmeijer et al (2020) and Chiang et al (2009) also placed an emphasis on positive memories. The current study did not, in order to investigate purely the effect of storytelling regardless of how positive or negative the memory was. When looking at the results of Veldmeijer et al (2020), Chiang et al (2009) and the current study, it seems that storytelling should be done with an emphasis on positive memories, in a group setting and repeatedly.

This suggestion would be in line with the conceptualisation of Riessman (2000), who describes storytelling as a social activity with that takes place between at least two people: a

storyteller and a listener. In the current study, participants engaged in storytelling in a room alone and wrote down their story on a PC in a room by themselves. Hence, there was no listener. It could be the case, that this more solitary execution of storytelling dampened the effect of storytelling, as most other studies that found effects, including Veldmeijer et al (2020) and Chiang et al (2009) used storytelling in more social settings, such as group therapy (Elias et al., 2020). However, there is one study that applied storytelling in a more solitary setting and found an effect (Pennebaker & Seagal, 1999). Participants engaged in storytelling repeatedly over the course of a few days and reported increased mental health (Pennebaker & Seagal, 1999). Pennebaker and Seagal (1999) noted that participants who benefitted most, described their stories in more positive terms and used more words that indicated high cognitive engagement. Thus, it seems that what makes storytelling effective is repeated engagement and an emphasis on positive accounts of the story that is told. Having an audience or participating in a group might be beneficial but does not seem necessary. These insights make sense against the background of the current study's results. The current study did not implement storytelling repeatedly nor did it place emphasis having a positive valence for the stories. Concludingly, the current study did not find a main effect of loneliness which might be due to a different implementation of it.

Next, it was hypothesised that in participants who watched the mysterious nature scene loneliness would decrease significantly (H2a) and that the difference in loneliness scores would be greater than in participants who watched the non-mysterious nature scene (H2b). The mysterious nature scene did decrease loneliness in the participants significantly, and the mean difference in loneliness scores in the mysterious nature condition was greater than in the non-mysterious nature condition. However, the difference between the two conditions was not significant. Thus, the current study could not find a main effect of mystery, even though the mysterious nature condition was the only one that decreased loneliness scores significantly. This makes the effect that mystery had on loneliness in this study a bit unclear. However, it does seem that the mysterious nature displayed in the video had some sort of influence. If virtual nature alone was what reduced loneliness scores, then there should have been a significant decrease in loneliness scores in the non-mysteriousness condition as well. Both videos used the same building blocks for the nature scenes; the same trees and grass and sky were used. So, the difference in the decrease in loneliness cannot be due to different types of virtual nature. The only difference between the videos was the composition of the nature elements; namely the placement of the trees, or the use of hills or no hills. Thus, the findings of this study are not

entirely conclusive about the effect of mystery, but it seems that it did have some sort of impact, even though it was not big enough to be statistically significant.

This goes against prior expectations as the findings of van Rompay and Jol (2016) and Otten et al (2022) suggested that mystery would be most suitable the nature characteristic for decreasing loneliness in this study. This begs the question of what could have caused the current study to find no main effect of mystery. Mysterious nature was chosen because of its connection to boosted creativity (van Rompay & Jol, 2016) and social connectedness (Otten et al., 2022), which impact feelings of loneliness (Mahon et al., 1996; Jose & Lim, 2014; Lim & Gleeson, 2014). Since thus far no study has investigated the direct impact of mysterious virtual nature on loneliness, it is difficult to say why no main effect of mystery was observed in the current study.

The current study reasoned that since creativity and social connectedness decrease loneliness, mysterious nature would also decrease loneliness. According to literature, creativity does have a negative impact on loneliness (Pauly et al., 2022), and feelings of social connectedness have been shown to reduce loneliness as well (O'Rourke et al., 2018). Mystery has been shown to increase both creativity and social connectedness (van Rompay & Jol, 2016; Otten et al., 2022).

Three suggestions are proposed to explain why mystery had no main effect in the current study. Firstly, the reason that now main effect was observed might lie with the set-up of the mysterious nature. Differences in the set-up of the mystery manipulation of the current study and the studies by van Rompay and Jol (2016) and Otten et al (2022) can be observed. The study by van Rompay and Jol (2016) used photographs of mysterious nature instead of virtual nature. Otten et al (2022) only used hills in the distance as a manipulation of mystery, while the current study employed hills in the distance, winding pathways, shadows and trees that obscure part of scene.

Secondly, van Rompay and Jol (2016) reported that a combination of mystery and spaciousness had the greatest impact on creativity. The non-mysterious condition of the current study featured a much more spacious nature scene than the mystery condition. Van Houwelingen-Snippe also suggested that spacious nature could be used to prompt people into more social interactions. Thus, it could be that no main effect of mystery was found the non-mysteriousness condition which was intended as a control condition, affected loneliness scores so much that the difference between the mystery conditions was not big enough to be significant anymore.

Lastly, since no other study has investigated a direct effect of mystery on storytelling, it is possible that mysterious nature only has a small influence on feelings of loneliness. In

conclusion, the main effect of mystery was not significant, even if the findings of the current study suggest that it did have a small effect. More research into this field of study is needed.

Next, it was assumed that a combination of watching the mysterious nature scene and completing the personal storytelling task would have the greatest effect of decreased feelings of loneliness (H3), which was not the case. Instead, it seems that the effect of storytelling and mystery actually had a reducing effect on each other. As evident in Figure 3, mystery and storytelling had the bigger effect when paired with the control condition of the other. Loneliness decreased most in the mystery – neutral writing condition followed by the storytelling – non-mystery condition. It seems that storytelling and mystery are most effective on their own and not when paired with one another. As far as known, at the point of conducting the current study, no other study has investigated a possible interaction effect of mysterious virtual nature and storytelling on loneliness, so there is no reference to compare this result to. However, since for both virtual nature and storytelling a decreasing effect on loneliness has been found by past studies (Liszio, Graf, & Masuch 2018; Veldmeijer et al., 2020), one would assume that the combination would also reduce loneliness. It is possible that storytelling and mystery reduce feelings of loneliness in different ways and that those ways are incompatible with each other. Storytelling, for example, has been proposed to make people feel more connected (Candlish, Fadyl & D'Cruz, 2022) while some studies have suggested that nature may improve mental wellbeing by distraction (Lopes, Lima, & Silva 2020). This would be incompatible as storytelling makes people focus on themselves as they are talking about an event that they have experienced themselves. This might interfere with the process of distraction from oneself and one's problems through nature. However, other studies have also found a connecting effect of nature and especially mysterious nature (Otten et al., 2022) so this does not seem to be causing the contradicting effects. More research into this topic is thus needed.

Lastly, awe, social aspirations, immersion, and nationality were examined as possible covariates. Only social aspirations were confirmed as covariate and predicted higher differences in pre and post loneliness scores. This finding is in line with prior assumptions, as the study by Nicolaisen and Thorsen (2017) found that the social aspirations that someone has are more important for not feeling lonely than the actual contact with peers. Thus, if a virtual nature scene induces more social aspirations in the participants loneliness scores would decrease more. This effect can be observed in the results of the current study a higher difference in loneliness scores was observed in participants who had higher social aspirations. Further, Otten et al (2022) suggested that mystery would be most suitable to induce social aspirations which can also be seen in the findings of the current study, as participants in the mystery condition reported the

highest social aspiration scores. However, no significant difference was found for social aspirations between the two nature video conditions, thus, this is merely a suggestion.

In the present study controlling for awe did not change the effects of mystery and storytelling, and awe was thus not a covariate. This is a positive finding as it means that awe did not account for any of the results found in the present study. Awe was measured as it has been suggested to buffer negative emotions, let people reassess their problems more easily and perceive them with a more relaxed stance (Powell et al., 2011). Awe has been connected to more spacious nature (Gootlieb, Keltner & Lombrozo, 2018) and not mysterious nature and since the non-mysterious condition was constructed in a more spacious way than the mysterious condition, it could have interfered with loneliness scores. Interestingly, mean awe scores were also higher in the non-mysterious condition. So, these results would support the assumption that awe is more related to spacious and vast nature. However, this cannot be said with certainty, was no significant difference was found for awe between the two nature conditions. Hence, this remains merely an additional suggestion.

Immersion was not confirmed as a covariate either. Immersion was examined as Liszio et al (2018) found that the higher the immersion the bigger the effect. Further, no significant differences in immersion were found between the two nature conditions. This suggests that both nature videos were equally immersive, which the current study aimed for.

5.2 Limitations and strengths

Firstly, since no main effect of mystery was found, it is possible that the mystery manipulation failed, as some participants remarked they had completed the experiment that they did not perceive the nature scene as particularly mysterious. Since no measure of mystery was included, it is not possible to know whether this was the case, which also makes it difficult to say whether there was no main effect of mystery simply because there is none or because the manipulation failed. It is, however, more possible that the first one is the case, as the video was pilot tested for mysteriousness and its set up was based on literature research.

Secondly, it might have been more conducive to evaluate the participants' social aspirations in general, rather than only the social aspirations that were induced by the nature video. The storytelling writing task might elicit social aspirations as well, if participants recounted a memory that included other people. So, measuring the social aspirations that participants were feeling after having watched the video and completed the writing task in general, rather than only the social aspirations elicited by the video, might have given a more realistic account of participants' social aspirations.

Thirdly, the participants of this study were all students which might make I difficult to generalise the findings to other populations, as students are a rather specific sample of young and educated people. Another hurdle for generalisability, is the cultural composition of the sample, as almost two thirds were German. However, the sample that was used in this study was very fitting to the population that it was supposed to examine, as it consisted entirely of students. Additionally, most research on how to decrease loneliness has been done on elderly. Thus, this study can be a valuable addition to the growing body of knowledge about loneliness.

Fourthly, this study investigated the effect between mysterious nature and storytelling which, so far, not much is known about. The results of this study, henceforth, provide new insights into possible ways of reducing loneliness.

5.4 Recommendations for future research and actual practice

More research needs be done to investigate the relationship of loneliness and storytelling, virtual nature, and mysterious nature. Research could explore what further conditions are required for storytelling to be effective, besides engaging in it for an extended period of time and possible focusing on positive memories. For example, it could be that different conditions are necessary for different cultures. More insight into how storytelling can be effective when done alone is also required.

Additionally, it needs to be further inspected whether loneliness can be reduced by experiencing virtual nature alone or whether mystery has some sort of effect after all, as the results of the current study suggest. A measure of perceived degree of mysteriousness could be included into the research design of future studies to be able to make statements about what exactly triggered a decline in loneliness scores. Additionally, the theory of attention restoration proposes that nature has three other characteristics that have restorative effects: vastness, soft fascination and compatibility (Kaplan, 1995). Therefore, it might be interesting to investigate the impact of these other characteristics on loneliness.

Since not much is known yet about the relationship between loneliness, mysterious nature and storytelling, some explorative qualitative research could be done where participants are asked to explain their experience, as well as why and how their feelings of loneliness changed or did not change. This might make it easier to perform quantitative research on the subject. Connectedly, it would be beneficial to find out more about how the interaction effect between storytelling and mystery works and how exactly they decrease the effect of the other.

Lastly, some longitudinal studies into the effects of mystery, virtual nature and storytelling on loneliness should be done, to see whether nature and storytelling could perhaps also be used as a prevention instead of a treatment.

A recommendation for future practice would be to implement storytelling and mysterious virtual nature in spaces where groups that are at risk of experiencing loneliness are often present. Since the results of the current study showed a significant decrease in loneliness scores in the whole student sample, universities could think about displaying virtual mysterious nature in libraries or lecture halls. Further, they could implement storytelling into lectures or organise events for it, to decrease feelings of loneliness in their students. As the mysterious nature condition had the biggest effect in reducing loneliness, a focus could be placed on implementing mysterious virtual nature.

5.5 Conclusion

This study aimed at answering the question how a storytelling writing task and mysterious nature can decrease loneliness in students. The findings of this study are not entirely conclusive but suggest that interventions using either storytelling or mysterious nature will be beneficial. As in general, performing a writing task and watching a virtual nature video made participants feel less lonely. The main effect of storytelling was not significant, but the results of the current study suggest that a storytelling task is nevertheless more effective than a neutral writing task. The main effect of mystery was not significant either, but the mysterious nature condition was the most effective in reducing loneliness scores which also suggests that mysterious nature does affect loneliness in some way. Finally, a combination of storytelling and mystery did not lead to higher reduction in loneliness. Instead, storytelling and mystery reduce the effectiveness of the other which is why the current study implementing either storytelling or mysterious nature. More research into this field of study is needed and the current study provides a basis for future studies to build upon.

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6. Appendix

6.1 Appendix 1

Pilot Test

Instructions:

Please rank the following videos from most mysterious to last mysterious, with 1 being the most and 14 the least mysterious.

Table 7

Results of the pilot test for the virtual nature video

Nature Scene	Participant										Total[a]
	1	2	3	4	5	6	7	8	9	10	
1	4	5	1	7	5	4	5	5	7	1	44
2	2	7	6	4	8	7	4	2	2	3	45
3*	1	1	3	5	1	2	1	1	4	2	21
4	3	6	5	13	6	6	2	4	3	7	55
5	5	4	2	2	7	3	3	3	1	8	38
6	7	8	8	1	3	5	9	8	9	6	64
7	6	2	4	9	4	1	7	7	6	4	50
8	11	3	7	3	2	10	6	6	8	5	61
9**	14	14	10	12	9	14	12	14	7	14	120
10	8	9	13	10	11	9	10	11	11	10	102
11	13	12	12	6	12	8	8	13	13	9	106
12	10	13	9	8	14	12	11	10	14	13	114
13	12	10	14	11+	10	13	13	12	12	11	118
14	9	11	12	14	13	11	14	9	11	12	116

* chosen mystery video

** chosen non-mystery video

[a] Added up rank scores of all participants for each video

6.2 Appendix 2

Welcome to our study about social connectedness, virtual nature and storytelling!

We thank you for taking the time to participate in our study. Please note, during the study you will not be able to go back to questions, as the order in which you answer them is important. Underneath you find the informed consent from.

Please do not hesitate to ask questions, should something be unclear.

Informed Consent:

Please take your time to read the following information carefully before proceeding to the experiment. Note that you can at any time, and without any penalty, withdraw from the experiment.

Who can participate?

Everyone between 18-30 years is invited to take part in this experiment. Your English reading and writing skills should be sufficient in order to understand questions and answer them.

What will happen during the experiment?

The experiment consists of four parts, which will approximately take 30 minutes, depending on your pace.

1. You fill in a short questionnaire

2. You will watch an animated video of virtual nature

3. You will be asked to perform a writing task (ca. 5 minutes). We may ask you for personal experiences here. Please be aware that all data will be handled anonymously in the system, so we will only see what you wrote, not that it was you. All information like names or places that are mentioned in your writing task will be censored once the data collection is finished, so that an identification of the author from the given information will not be possible.

4. You will fill out a short questionnaire again.

We will not give you more detailed information now, because we do not want to bias your answers. If you are interested in our research, we will gladly debrief and explain it to you in detail after your participation.

What are the risks?

We do not expect any potential harming side-effects, but should something make you very uncomfortable, please do not hesitate to reach out to us.

What happens with the collected data?

As mentioned, all data will be kept an anonymously and confidentially. No information that could lead to identification of someone will be shared. We will ask you for your email to participate in the voucher-raffle, but this will be independent from the experiment and there is

no possibility of relating your answers in the experiment to your email.

<u>What do I get in return?</u>

If you participated via the SONA-credit system, you will be granted 1 SONA-point.
Additionally, all participants will be given the chance to win a 20€ voucher of thuisbezord.nl,
a food-delivery service founded and based in Enschede. The winners will be contacted
personally via email after our data collection is finished.

<u>By clicking to the next page you agree to the following:</u>

I understand the terms and conditions of this study. I am aware that participation is voluntary
and that I can withdraw from it anytime. Hereby, I agree to participate in the study:

6.3 Appendix 3

Table 8

Factor Loadings

Items	Factor Loadings				
	Factor 1 Connectedness and Vastness	Factor 2 Loneliness	Factor 3 Diminished Self	Factor 4 Immersion	Factor 5 Social Aspirations
I am unhappy being so withdrawn.		.69			
I feel isolated from others.		.76			
I lack companionship.		.65			
I feel left out.		.74			
People are around me but not with me.		.60			
I feel part of a group of friends.		.67			
I am fine being on my own.		.38			
There is someone who understands me.		.52			
I am at peace with nature of my social relations.		.67			
I feel in tune with people around me.		.60			

I have things in common with the people around me.		.47	
I feel that there are enough people around me.		.67	
I would like to show this landscape to someone.			.45
I would like to meet there with a friend.			.81
I would like to have a spontaneous chat.			.46
This landscape is suitable to experience together.			.71
If I would encounter someone here, I would feel uncomfortable.			.61
I felt that my sense of self was diminished.		.82	
I felt my sense of self shrink.		.86	
I experienced a reduced sense of self.		.84	
I felt my sense of self become somehow smaller.		.81	
I felt small compared to everything else.		.52	
I had the sense of being connected to everything.	.73		
I felt a sense of communion with all living things.	.71		
I experienced a sense of oneness with all things.	.78		
I felt closely connected to humanity.	.43		

I had a sense of complete connectedness.	.66				
I felt that I was in the presence of something grand.	.74				
I experienced something greater than myself.	.77				
I felt in the presence of greatness.	.72				
I perceived something that was much larger than me.	.68				
I perceived vastness.	.45				
I felt like I was actually there in the environment of the presentation.				.82	
It was as though my true location had shifted into the environment in the presentation.				.75	
I felt as though I was physically present in the environment of the presentation.				.80	
It seemed as though I actually took part in the environment of the presentation				.81	
Cronbach's alpha	.90	.87	.90	.91	.63

Appendix 4

Loneliness questionnaire

Instructions pre measurement

Here are some statements concerning your feelings. Please, indicate how much these statements apply to you at this moment, by clicking on one circle. Please, answer intuitively without thinking about them too much.

Instructions post measurement

Again, here are some statements concerning your feelings. Please, indicate how much these statements apply to you at this moment, by clicking on one circle. Please, answer intuitively without thinking about them too much.

Item1: I am unhappy being so withdrawn.

Item 2: I feel isolated from others.

Item 3: I lack companionship.

Item 4: I feel left out.

Item 5: People are around me but not with me.

Item 6: I feel part of a group of friends.

Item 7: I am fine being on my own.

Item 8: There is someone who understands me.

Item 9: I am at peace with nature of my social relations.

Item 10: I feel in tune with people around me.

Item 11: I have things in common with the people around me.

Item 12: I feel that there are enough people around me.

Appendix 5

Social Aspirations questionnaire

Instructions:

Please, think back to the nature video you just saw. In the following, you will see some statements regarding how you feel in this moment. Please answer them by choosing the option that intuitively fits most for you.

Item 1: I would like to show this landscape to someone.

Item 2: I would like to meet here with a friend.

Item 3: I would like to have a spontaneous chat.

Item 4: This landscape is suitable to experience together.

Item 5: If I would encounter someone here, I would feel uncomfortable.

Appendix 6

Awe questionnaire

Instructions:

Again, please answer with regards to how you feel right now after having watched the nature video. Please answer them by choosing the option that intuitively fits most for you.

Item 1: I felt that my sense of self was diminished.

Item 2: I felt my sense of self shrink.

Item 3: I experienced a reduced sense of self.

Item 4: I felt my sense of self become somehow smaller.

Item 5: I felt small compared to everything else.

Item 6: I had the sense of being connected to everything.

Item 7: I felt a sense of communion with all living things.

Item 8: I experienced a sense of oneness with all things.

Item 9: I felt closely connected to humanity.

Item 10: I had a sense of complete connectedness.

Item 11: I felt that I was in the presence of something grand.

Item 12: I experienced something greater than myself.

Item 13: I felt in the presence of greatness.

Item 14: I perceived something that was much larger than me.

Item 15: I perceived vastness.

Appendix 7

Immersion questionnaire

Instructions:

For each item, please indicate how much agree or disagree with these statements regarding your experience watching the nature video.

Item 1: I felt like I was actually there in the environment of the presentation.

Item 2: It was as though my true location had shifted into the environment of the presentation.

Item 3: I felt as though I was physically present in the environment of the presentation.

Item 4: It seemed as though I actually took part in the environment of the presentation.