The presence and characteristics of mental (intrusive) images in people with elevated fear of heights

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Master Thesis

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Abstract

Background and aim:

Mental intrusive images play a role in the onset and maintenance of mental disorders. The presence of intrusive mental images in acrophobia could be a specific angle on this matter but is not investigated yet. Therefore, this study aimed to explore the presence and characteristics of mental (intrusive) images in people with elevated fear of heights (EFOH) compared to people with low fear of heights (LFOH).

Method:

A between-subject design and a 2x2 mixed design were used to explore the differences in mental imagery characteristics between and within the EFOH (n=21) and LFOH (n=24) group. Participants were exposed to heights through virtual reality. The EFOH and LFOH groups were composed based on a cut-off score on the Acrophobia Questionnaire anxiety scale, in reference to a clinical sample.

Results:

The EFOH group reported more intrusive images in everyday life but not during height exposure compared to the LFOH group. No differences in perspective, vividness and emotionality between the groups were found during height exposure. Unpredictably, mental images of LFOH groups were more negative than EFOH. Finally, an interaction effect of group and exposure on emotionality was found. A trend was visible for vividness.

Conclusion and discussion:

This study found evidence for intrusive images in everyday life in EFOH. However, results during height exposure were mixed, possibly due to the group composition and VR-environments. Future research is necessary to undermine the results of this study.

Keywords: Mental intrusive imagery, elevated fear of heights, virtual reality

Introduction

Acrophobia (an irrational fear of heights) is a chronic disorder with low rates of spontaneous remission. It harms the quality of life by causing social impairment in everyday tasks such as walking on stairs, and it increases the risk of a comorbid panic attack, agoraphobia and depressive- and anxiety disorders (Kapfhammer, Fitz, Huppert, Grill & Brandt, 2016). A recent systematic review examined the effect rates of the main interventions for acrophobia, including the most recommended treatment in the Netherlands, exposure therapy (Trimbos Institute, 2013). The review found that the efficacy of treatments for acrophobia is effective in the short term but not in the long run (Arroll, Wallace, Mount, Humm & Kingsford, 2017). A better understanding of the etiology and maintaining factors involved in acrophobia could hence highlight new treatment targets to gain treatment effects in the long run.

The inhibitory learning model of Craske (2015) provides the working mechanism of exposure therapy in acrophobia. Within this model, height is associated with fear. The goal of exposure therapy is to create and strengthen a competing non-threat expectancy because the level of fear depends on the activation of the threat (height-fear) or non-threat (height-no fear) expectancy. To strengthen the non-threat expectancy, patients are systematically exposed to cues that are feared, avoided, or endured with dread (Craske, 2015). However, exposure therapy does not actively aim to change mental images of the feared object/scenario. This is interesting because evidence suggests that mental images play a role in the onset and maintenance of psychological disorders via its impact on emotion (Brewin, Gregory, Lipton & Burgess, 2010; Hackmann & Holmes, 2004).

A mental image is a mental representation which is associated with the activation of sensory modalities with or without a direct external stimulus (Pearson, Naselaris, Holmes, & Kosslyn, 2015). Mental images can be involuntary or voluntary retrieved.
Involuntary/intrusive images are mental representations which appearance in consciousness is spontaneous rather than following a deliberate effort or search (Brewin et al., 2010; Kadriu et al., 2019). The content of (intrusive) images varies across psychological disorders and often match the specific content of thoughts of the psychological disorder (Çili & Stopa, 2015). The valence of the mental image is related to actual avoidance (negative image) or approach behaviour (positive image). For example, mental images in agoraphobia center around physical or mental catastrophic fears such as “passing out in public” and this results in the avoidance of being in public (Hackmann, Day & Holmes, 2009). In contrast, an image of substance abuse elicits craving (Holmes & Mathews, 2010). Thus, images in fear of heights could reflect signals of threat, which results in avoidance of heights, which prevents updating

the distorted image which maintains the disorder (Çili & Stopa, 2015; Conway, 2001; Hackmann & Holmes, 2004).

Although increasing empirical research indicates that intrusive imagery is a transdiagnostic process (Brewin et al., 2010), intrusive images are only part of the Diagnostic and Statistical Manual of Mental Disorders (5th ed; DSM-5; American Psychiatric Association, 2013) as a criterium of post-traumatic stress disorder (PTSD), acute stress disorder and obsessive-compulsive disorder (OCD). Moreover, psychological treatments tailored to target intrusive images, reduces symptoms in mental disorders, including disorders without the criteria of intrusive images (Rusch, Grunert, Mendelsohn & Smucker, 2000). For example, Imagery rescripting (ImRs), a technique that directly modifies the content of emotion-inducing imagery, is more effective than exposure therapy in a specific phobia of snakes (Hunt et al., 2006; Hunt & Fenton, 2007). Because of the lack of effective treatments for acrophobia in the long term and the effectiveness of techniques that target and modify mental images, this study investigated the presence and characteristics of mental images in acrophobia.

Because this study is the first to investigate mental (intrusive) imagery in acrophobia, studies to intrusive imagery in other anxiety disorders are worth mentioning. According to the review of Çili and Stopa (2015), intrusive images are often recurrent. Images can be triggered by specific stimuli (both situational and internal). The study of Pratt, Cooper and Hackmann (2004) to the presence of intrusive images in spider phobia, found that 69% of the spider-anxiety group reported recurrent intrusive images of spiders in everyday life as opposed to 0% in the control group. In the specific phobia of vomiting, 80.6% of people with a specific phobia of vomiting reported intrusive imagery when anxious about their phobia (Price, Veale & Brewin, 2012). Moreover, agoraphobic patients in the study of Day, Holmes and Hackmann (2004) experienced intrusive images in agoraphobic situations compared to none in the control group. Therefore, the presence of intrusive imagery seems related to the feared situation.

Apart from the presence, mental images are described in characteristics, such as vividness (experiencing a mental image as being real), negativity and emotionality. Emotional images are experienced with greater vividness than neutral images and are present in several disorders (Brewin et al., 2010; Hackmann & Holmes, 2004). Moreover, a reduction in vividness and emotionality of mental images is associated with less symptomatology in some disorders (Brewin et al., 2010). Concerning specific phobias, Pratt et al. (2004) found that spiders anxious people experienced self-generated images that were more vivid and evoked

more anxiety than people with no spider anxiety. However, in a situation unrelated to their fear of spiders (imagining a butterfly), no differences in vividness and emotionality of the image were found between the spider phobic and the control group. In other words, the degree of vividness and emotionality of the mental image appears to be related to the individual's particular concern/fear. Therefore, it is hypothesized that height exposure has an impact on characteristics (vividness, negativity and emotionality) of (intrusive) images in people with elevated fear of heights but not in people without fear of heights.

Research has also focused on the perspective of the mental image. Images are experienced from a field (first-person/one's one) perspective or an observer (third-person/outsider) perspective. The emotionality of the image is influenced by the perspective from which the image is viewed (Holmes & Mathews, 2009). Instructions to switch the perspective from field to observer result in the reduction of the emotional rating of the image (Berntsen & Rubin, 2006). Therefore, deliberate adoption of an observer perspective may be used by anxious people to reduce the distress of the mental image and is common in social phobia (Clark & Wells, 1995), agoraphobia (Day, Holmes & Hackmann, 2004) and PTSD (McIsaac & Eich, 2004). Therefore, it is hypothesized that people with acrophobia experience height-related mental images from an observer perspective.

This exploratory study sought to investigate the presence and characteristics of mental (intrusive) images in everyday life and during height exposure in participants with elevated fear of heights (EFOH) compared to people with low fear of heights (LFOH). Based on the transdiagnostic character of mental (intrusive) images, this study hypothesized that participants with EFOH experience more intrusive images in everyday life (1a) and during height exposure (1b) than participants with LFOH. Next, it is hypothesized that participants with EFOH experience their image from an observer perspective during everyday life (2a), and during height exposure (2b). In contrast, participants with LFOH are expected to report the field perspective. Moreover, the mental images of participants with EFOH are expected to be more vivid, negative and emotional during height exposure than participants with LFOH (3). Finally, an interaction effect between group (EFOH vs LFOH) and exposure (height vs ground) on vividness, emotionality and negativity is expected (4).

This study assessed (intrusive) imagery in everyday life and during height exposure by adopting the social anxiety imagery questionnaire of Homer and Deeprose (2017) to an imagery questionnaire related to heights. Virtual reality (VR) was used to expose participants to height and ground environments. Furthermore, participants were divided into an EFOH and an LFOH group.

Method

2.1 Participants

The study received approval from the University of Utrecht (UU) Ethics Committee (FETC17-103). Participants were recruited from the community through (online) flyers. The flyers attempted to target people with fear of heights using the heading "Study to fear of heights using virtual reality". Because of time constraints, participants were not screened on a minimum level of fear of heights. The only requirement was the ability to speak and read Dutch.

Participants were divided into an EFOH and LFOH group based on their score on the Acrophobic Questionnaire anxiety subscale (AQ; Cohen, 1977). To be considered for inclusion to the EFOH group, this study aimed to use the same cut-off scores of the AQ as Steinman and Teachman (2011) and Dreyer-Oren, Clerkin, Edwards, Teachman and Steinman (2019). These studies used a cut-off score of one standard deviation below the mean of a previous acrophobic sample (45.45) (Cohen, 1977). However, this cut-off score resulted in a skewed distribution. Since six people ranged between scores of 43-45.45, this study lowered the cut-off score to be included for the EFOH to 43.

Statistical power calculation

A priori sample size calculation revealed a required sample size of 46 to detect a medium to large effect with a power of .80 and an alpha of .05 (Cohen, 1988; Faul, Erdfelder, Lang, & Buchner, 2007). Because one participant was excluded due to insufficient understanding of the Dutch language, the final sample consisted of 45 participants (M^{age} = 23.24, SD = 2.77).

2.2 Materials

2.2.1 Experimental stimuli

Virtual reality

VR can be used as a stress induction method allowing first-person perspective experiences. The stress response shares similarities to real traumatic situations but is less intense (Courtney, Dawson, Schell, Iyer, & Parsons, 2010). Therefore, the use of VR-height environments is an ethical way of exposing people to heights. Furthermore, a VR-paradigm is associated with high intrusion levels (Dibbets & Schulte-Ostermann, 2015).

This study used an Oculus Rift CV1 Virtual Reality headset with two Oculus trackers on a Windows 10 x64 computer. The VR environment used in this study was a replica of the Muziekgebouw aan 't IJ, a concert building in Amsterdam. Two ground-positions, two height-

positions, and one position to accustom were used in the VR-environment. Participants were exposed for one minute to each VR-position in which different participants were able to experience the environment in 360 degrees and set a step in any direction.

2.2.1.1 VR-Environments

VR-accustom phase

The VR-accustom position was set on ground level, in which the participant stood underneath the ceiling of the first floor without any height exposure, see Figure 2. Instructions given included: “Turn around and describe what you see”.

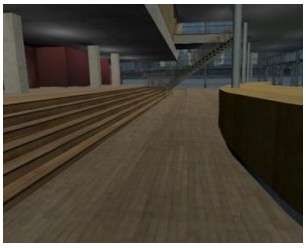

Figure 2. The VR-accostum environment

VR-ground phase

The VR-ground phase consisted of two positions in which participants were able to look up to all three balconies and the ceiling of the building, see Figure 3. An example of an instruction given: "Can you estimate how tall the building is?"

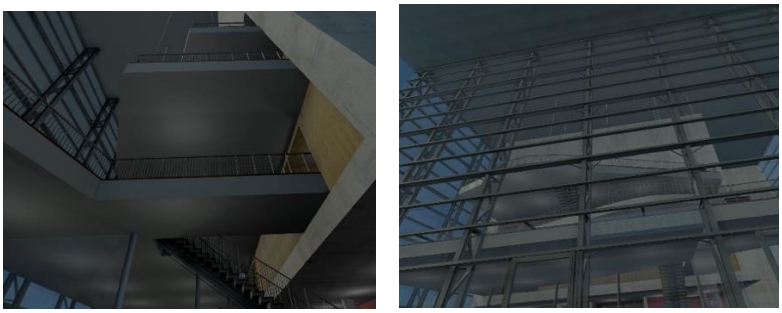

Figure 3. The VR-ground environments

VR-height phase

The VR-height phase consisted of two positions, see Figure 4. In the first height-position, participants stood on the first floor and were instructed to set a step on a glass floor and to look down. In the second height-position, participants spawned on the third floor of the building in front of a safety bar. The safety bar within the VR-environment corresponded with

the safety bar in front of the participants in the "real world". Participants were instructed to grab the bar, to bend over the bar, and to look down.

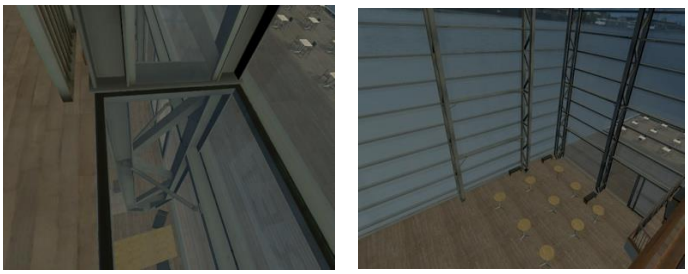

Figure 4. The VR-height environments

2.2.3 Outcome measures

Elevated fear of heights

This study used a translated version of the Acrophobia Questionnaire (AQ; Cohen, 1977) to measure fear of heights and to create the LFOH and EFOH group. The AQ consists of an anxiety and an avoidance subscale. The anxiety-subscale consists of 20 height situations (e.g., on the roof of a ten-story apartment building) in which participants rate how anxious they would feel on a 7-point scale (0= not at all anxious; to 6=extremely anxious). The AQ-anxiety scale is a widely used scale of measurement of acrophobia and has good psychometric properties (Dreyer-Oren et al., 2019). Since there is no data about the reliability of the Dutch translation of the AQ, a reliability analysis was executed for this study for the anxiety-subscale, which found an excellent Cronbach's alpha of .92.

Imagery ability

The general ability to form vivid mental images was measured by a Dutch translation of the shortened version of the Quality of Mental Imagery Questionnaire (QMI; Sheehan, 1967). The shortened version of the QMI consists of 35 statements regarding seven different sensory modalities: visual, auditory, cutaneous, kinesthetic, gustatory, olfactory, and organic. The QMI uses a seven-point scale to indicate the extent to which the image was (1) "perfectly clear and as vivid as the actual experience" to (7) "no image present at all". The internal consistency of the QMI is high, with reliability coefficients ranging between .91 and .95 (Juhasz, 1972). Since the QMI was translated to Dutch in this study this study, a reliability analysis was executed, which found an excellent Cronbach's alpha of .96.

The presence and characteristics of mental (intrusive) images in everyday life

Since no questionnaire about mental (intrusive) imagery related to height exists, a questionnaire was constructed based on the Plymouth Questionnaire (PQ; Homer & Deeprose, 2017). The PQ assess intrusive imagery in social phobia and is based on a widely cited semi-structured interview regarding intrusive imagery in social phobia (Hackmann, Clark & McManus, 2000; Homer & Deeprose, 2017). The questionnaire used in this study is called the Plymouth Questionnaire adapted to height (PQ-H).

The PQ-H starts with a description of recurrent, intrusive and negative mental images. Subsequently, the PQ-H asks whether the participant experiences intrusive images related to heights in everyday life. If so, participants had to describe the content of the image. Next, participants had to report the perspective of the image (first- or third person). Participants who did not experience any recurrent, intrusive and negative mental images (based on heights) were requested to generate an anxious image related to heights. These participants had to report the content and perspective of the image. The response mode for the content of the image was a comment box. For the perspective of the image, participants had to choose between a first-person or third-person perspective.

The presence and characteristics of mental (intrusive) images during height exposure

To measure (intrusive) imagery during VR ground and VR height exposure, the PQ was also adapted to the VR-environment (PQ-VR). The PQ-VR asked precisely the same questions as the PQ-H. However, the items are related to mental (intrusive) images in the VR-environment and not in everyday life.

Vividness, emotionality and negativity of mental image

The degree of vividness, emotionality and negativity of the mental image during VR-ground and VR-height exposure, was measured with 100mm visual analogue scale (VAS), ranging from not at all (0) to extremely (10). VAS is a widely used method in mental imagery studies (O'Donnell, Simplicio, Brown, Holmes & Heyes, 2018).

2.4 Procedure

Participants received information about the study, provided with informed consent on paper. All questions/questionnaires were asked on a computer with the online survey software Qualtrics (Qualtrics, 2005). Participants were instructed to answer demographic questions, the AQ, QMI and PQ-H. When finished, participants had to stand between a square of safety-

railings, and the instructor provided the participants with the VR-headset. The instructor than placed the participants into the VR-accustom position. Subsequently, the instructor performed healthy checks by asking if the participants were sick, dizzy or had feeble knees.

Participants were randomly assigned to pathway 1 and pathway 2. Participants progressed through to the VR-height phase or VR-ground phase in counterbalanced order depending on their pathway (see Figure 1). After each VR-phase, participants had to answer AQ-VR and the VAS. Finally, the participants were debriefed and compensated for their participation (2 euros per 15 minutes).

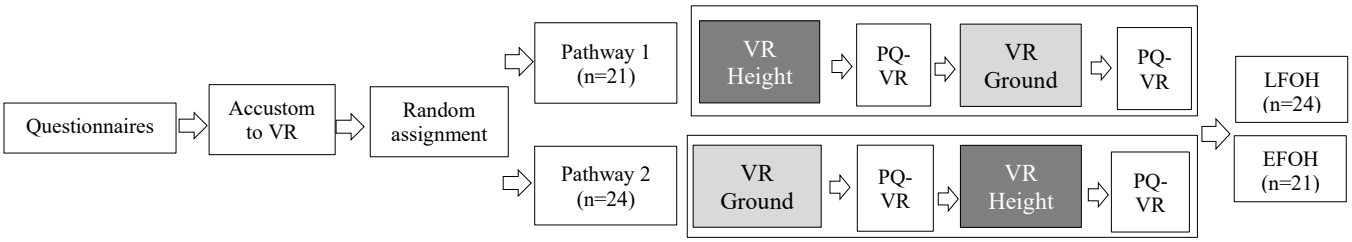

Figure 1. Study flowchart. After completing multiple questionnaires, participants accustomed to virtual reality. Subsequently, participants were randomly divided into pathway 1 or pathway 2. In both pathways, participants completed the Plymouth Questionnaire adapted to VR (PQ-VR). Participants were divided into the EFOH or NFOH based on their score on the AQ-anxiety scale.

2.5 Design

The study used a between-subject design to explore the differences between people with EFOH and LFOH in the presence and characteristics of mental (intrusive) images in everyday life and during height exposure. Moreover, this study used 2x2 mixed design to investigate the interaction effect of exposure (height vs ground) and group (EFOH vs LFOH) on vividness, emotionality and negativity of the mental image.

2.6 Data-analysis plan

Baseline, randomization and manipulation checks

All analyses were carried out with the Statistical Package for Social Science (SPSS) version 25. Significance level was set on $p<.05$ (two-tailed). Baseline checks for the EFOH and LFOH group were performed using one-way ANOVA's. Moreover, randomization checks between pathway 1 and pathway 2 were performed regarding fear of heights and mental imagery ability.

After baseline and randomization checks, one-way ANOVA's to the difference in vividness, emotionality and negativity between intrusive and non-intrusive images were carried out to check if these images could be merged. Due to the counterbalancing design, one-way ANOVA's were performed to check whether mental images between the two pathways were equal in vividness, emotionality and negativity and could, therefore, be assembled.

Main analysis

To explore whether people with EFOH and LFOH differed in mental imagery characteristics in everyday life and during VR-height exposure, one-way ANOVA's and chi-square tests were conducted. Next, a 2x2 mixed model ANOVA with a within factor (VR-height and VR-ground) and a between factor group (EFOH and LFOH) was used to investigate the interaction effect between group and exposure on vividness, emotionality and negativity.

Results

3.1 Demographic characteristics

The EFOH group consisted of 21 participants (6 males; 15 females) with an average age 23.81 (SD = 6.62). The LFOH group consisted of 24 participants (12 males; 12 females) with an average age of 22.75 (SD = 2.69). No significant differences between the two groups were found in age, F (43) = .518, p = .476 and in mental imagery (QMI total score), F (43) = .418, p = .521. As expected, the EFOH scored significantly higher on the AQ (M = 56.62, SD = 13.04) than the LFOH group (M = 31.75, SD = 5.37) with Welch's F (1, 25.88) = 66.55, p < .001.

3.2 Randomization check

No differences were found between pathway 1 and pathway 2 in the variables age, fear of heights and mental imagery ability: age F (1, 43) = .46, p = .503, AQ-anxiety score, F (1, 43) = .33, p = .571, and QMI-total score, F (1, 43) = 2.92, p = .0.95. Therefore, the randomization was successful. However, considering the p-value of the QMI-total score, further analyses on subscale level were performed. Participants in pathway 2 scored significantly higher on the cutaneous subscale (M = 27.71, SD = 4.34) compared to pathway 1 (M = 24.38, SD = 5.56), F (1,43) = 5.07, p = .030. The same applies for the score on the olfactory subscale in which pathway 2 scored significant higher (M = 23.63, SD = 5.011) than pathway 1 (M = 18.29, SD = 18.29), F (43) = -3.03, p = .004.

3.3 Data Inspection

There were no missing data. Moreover, one-way ANOVAs showed no significant differences in vividness, emotionality and negativity between intrusive and non-intrusive images within the two pathways. Therefore, intrusive and non-intrusive images were merged into one group. Finally, one-way ANOVAs were performed to control whether mental images during height exposure differed in vividness, emotionality and negativity between the two pathways. No differences were found between the two pathways in vividness, F (1,43) = .16, p = .21 and emotionality F (1,43) = .937, p = .34. Unexpectedly, participants in pathway 2 scored significantly higher on negativity during height exposure (M = 52.71; SD = 25.26) than participants in pathway 1 (M = 28.71; SD = 31.38), with F (1,43) = 8.07, p = .007.

Due to the unexpected difference between EFOH and LFOH in the negativity of the image during height exposure, hypotheses related to height exposure were analyzed within the two pathways. Because intrusive imagery in everyday life was measured before the actual experiment, intrusive images in everyday life were not analyzed within the two pathways. The same applies to the interaction effect since the counterbalanced design should diminish any order effects. Therefore, the number of participants in groups differs between hypotheses.

3.4 Hypotheses

Hypothesis 1a: Presence of intrusive images in everyday life

As shown in Table 1, nine participants (43%) of the EFOH group reported intrusive images in everyday life compared to two participants (8%) in the LFOH group. The percentage of intrusive images in EFOH was significantly higher than LFOH participants, X^2 (1, N = 45) = 7.22, p = .007, with a Cramer's V of .401 indicating a "medium-to-large" effect (Cohen, 1988).

Table 1

The presence and perspective of intrusive images in everyday life in participants with EFOH and LFOH. The presence percentage concerns the percentage of the whole group. The perspective percentage concerns the percentage of intrusive images.

	EFOH (n=21)	LFOH (n=24)
Presence of intrusive images in everyday life	**9** (43%)	**2** (8%)
Perspective:		
Field	5 (56%)	1 (50%)
Observer	4	1

Hypothesis 1b: Presence of intrusive images during height exposure

During height exposure, no difference in frequency of the presence of intrusive images between EFOH and LFOH were found within pathway 1 and 2 (see Table 2). Within pathway 1, 3 participants (30%) with EFOH reported intrusive images versus 5 (46%) in LFOH. Within pathway 2, 4 participants (36%) with EFOH reported intrusive images versus 4 (31%) in LFOH.

Table 2

The presence and perspective of intrusive images of the EFOH and LFOH during VR-height exposure within pathway 1 and 2. The percentage of presence concerns the percentage of the entire group. Percentage of perspective concerns the percentage of intrusive images.

	Pathway 1		Pathway 2	
	EFOH (n=10)	LFOH (n=11)	EFOH (n=11)	LFOH (n=13)
Presence of intrusive image	3 (30%)	5 (46%)	4 (36%)	4 (31%)
Perspective:	9 (90%)	10 (91%)	11	13 (100%)
Field	1	1	(100%)	0
Observer			0	

Hypothesis 2a: Perspective of intrusive image in everyday life

Of the 9 participants with intrusive images in everyday life in the EFOH group, 5 participants (56%) reported a mental image from a field perspective and 4 participants from an observer perspective. In the LFOH group, 1 participant (50%) experienced field perspective, and 1 participant reported an observer perspective, see Table 1. Therefore, no difference in perspective was found between the two groups.

Hypothesis 2b: Perspective of mental image during height exposure

During height exposure, all participants (except two) experienced their image from an observer perspective, see Table 2. In pathway 1, 9 participants with EFOH (90%) and 10 participants with LFOH (91%) experienced their image from a field perspective. All participants in pathway 2 experienced their image from an observer perspective. Therefore, the hypothesis that participants with EFOH more often report an observer perspective is rejected.

Hypothesis 3: Vividness, emotionality and negativity during height-exposure

One-way ANOVAs were conducted to test the hypotheses that participants with EFOH experience mental images more vivid, emotional and negative during height exposure than people with LFOH. In contrast to these hypotheses, no differences in vividness, emotionality and negativity between EFOH and LFOH were found within pathway 1 and 2 except for negativity in pathway 2, see Table 3. Unexpectedly, the images of people with LFOH in pathway 2 were more negative (M=6.53, SD=1.79) than the images of EFOH participants (M=3.78, SD=2.52). This difference (-2.78) was significant F (1,22) = 9.74, p = .005.

Table 3

Difference in vividness, emotionality and negativity scores of the mental image (intrusive and non-intrusive merged) between EFOH and LFOH within pathway 1, 2 and pathway 1+2 during height exposure.

	EFOH		LFOH		*p*-value
			Pathway 1 (n=21)		
	M	SD	M	SD	
Vividness	5.50	2.55	4.73	3.02	.535
Emotionality	3.40	3.31	1.82	1.89	.189
Negativity	3.72	3.32	2.10	2.90	.247
			Pathway 2 (n=24)		
Vividness	5.82	2.23	6.15	1.91	.695
Emotionality	3.82	2.56	2.92	2.60	.406
Negativity	3.78	2.52	6.53	1.79	.005
			Pathway 1+2 (n=45)		
Vividness	5.67	2.33	5.50	2.52	.820
Emotionality	3.62	2.87	2.42	2.32	.128
Negativity	3.75	2.85	4.50	3.23	.418

Hypothesis 4: Interaction effect

As expected, a significant interaction effect was found between group and exposure on emotionality, F (1,43) = 4.42, p = .041, with a large effect size (η^2 = .54) (Cohen, 1988). Participants with EFOH dropped significantly in their emotionality scores on height (M = 3.62, SD = 2.87) vs ground exposure (M = 2.52, SD = 2.09). The LFOH did not decrease in their scores over time: VR-height (M = 2.42, SD = 2.32) vs VR-ground (M = 2.33, SD =

2.37). Although a trend was visible, see Figure 3, no significant interaction effect between group and exposure on vividness was found: (1,43) = 1.95, p = .169. No significant interaction between group and exposure on negativity was found: F (1,43) = .027, p = .869, see Figure 4.

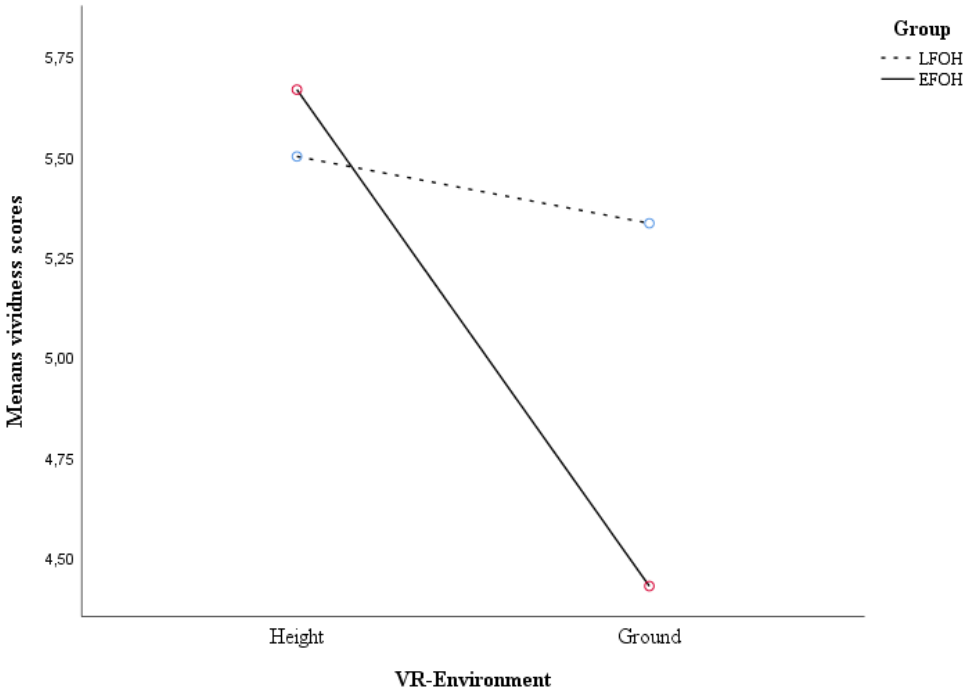

Figure 2. Graph display of mean mental image vividness scores of the EFOH and LFOH group during VR-height and VR-ground exposure.

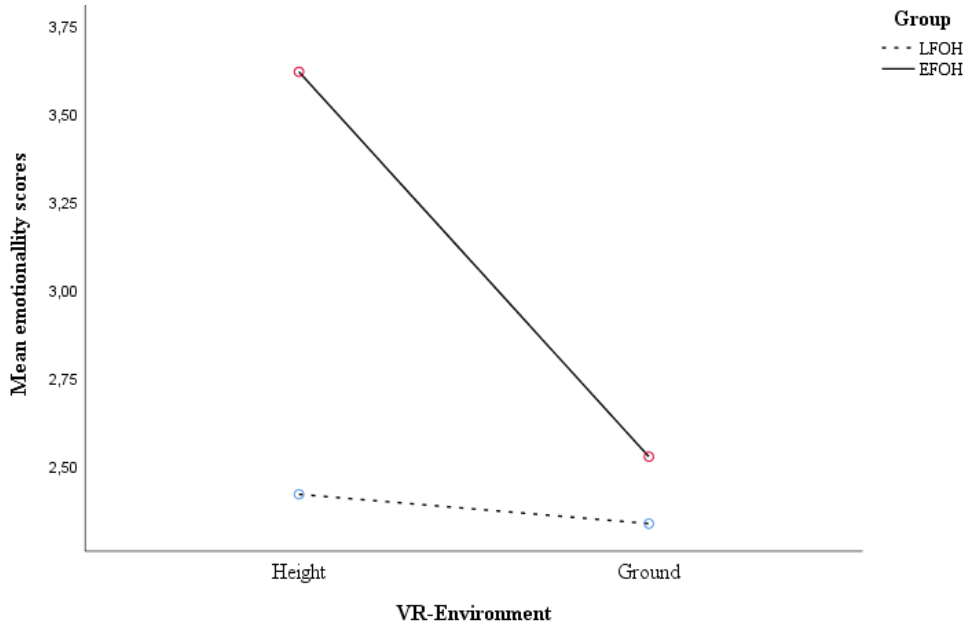

Figure 3. Graph display of mean mental image emotionality scores of the EFOH and LFOH group during VR-height and VR-ground exposure.

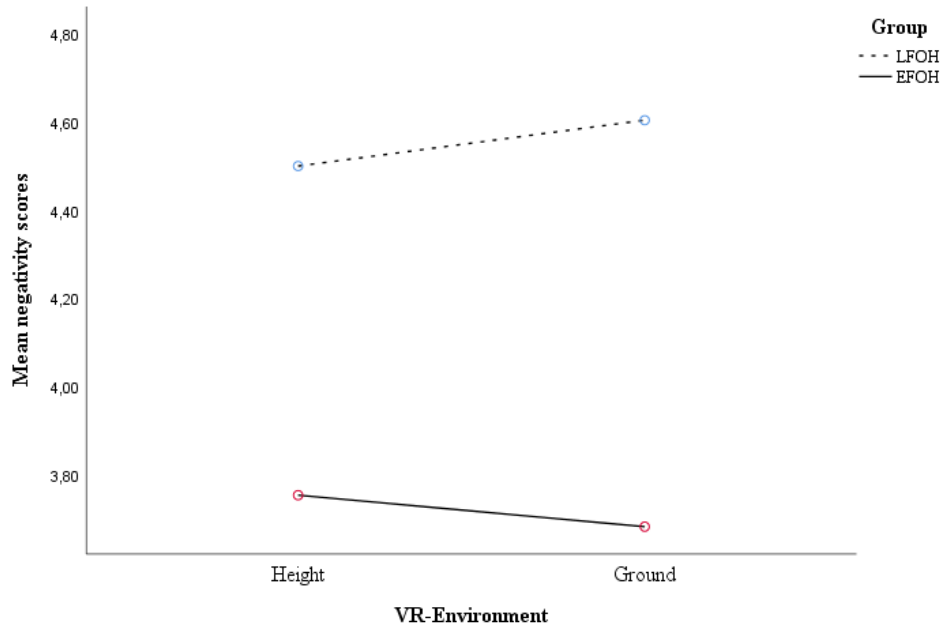

Figure 4. Graph display of mean mental image negativity scores of the EFOH and LFOH group during VR-height and VR-ground exposure.

Discussion

This study is the first to investigate the presence and characteristics of mental (intrusive) imagery in EFOH. Consistent with the expectation, intrusive images in everyday life were significantly more present in the EFOH group than in the LFOH group. Compared to intrusive images in other phobias (69% in spider phobia, Pratt et al., 2004; 80.6% in a phobia of vomiting; Price et al., 2012; 87% in social phobia, Homer & Deeprose, 2017), the percentage of intrusive images in the anxious group in this study is lower (46%). However, the phobic groups in the studies mentioned above were more anxious than the phobic group in the current study. For example, the vomiting phobic group in the study of Price et al. (2012) required a DSM-5 diagnosis. Given the impact of intrusive images on emotion, it is likely that a clinical acrophobic sample will experience even more intrusive images.

Although this study found a significant difference between EFOH and LFOH in the presence of intrusive imagery in everyday life, intrusive images were not more present in the EFOH than the LFOH group during height exposure. This is not in line with previous studies to intrusive imagery in anxiety disorders in which intrusive imagery took place during anxious situations (e.g. Day et al., 2004; Pratt et al., 2004). Wuehr et al. (2019) investigated anxiety levels of 14 acrophobic and 10 non-acrophobic participants in multiple VR-height environments ranging from 0 to 100 meters above ground. Wuehr et al. (2019) found that anxiety-levels increased with the level of heights with a difference in anxiety-levels between

acrophobic and non-acrophobic participants, starting from 40 meters above the ground. However, the current study used height-locations approximately 3 (first floor) and 10 (third floor) meters above the ground. Therefore, the height-environments in the present study were not high enough to be classified as anxious (Wuehr et al., 2019). In fact, since the current study used a subclinical acrophobic sample as compared to the clinical acrophobic sample in Wuehr et al. (2019), height-environments should even be higher than 40 meters above ground.

Unexpectedly, the EFOH group was no more likely to experience an image in everyday life and during height-exposure from the observer perspective than the LFOH group. In everyday life, almost half of the EFOH group experienced an intrusive image from an observer perspective. However, during height-exposure, only one participant in the EFOH experienced an image from an observer perspective. A possible explanation is the "non-anxious" height environments in this study. Shifting to an observer perspective is a coping mechanism to reduce the emotional rating of a mental image (Berntsen & Rubin, 2006). Since the height environment in this study was not sufficient for the EFOH group to create anxiety (Wuehr et al., 2019), there was no need for the participants to switch the image to an observer perspective.

As shown in Table 3, the present study did not find a difference between the EFOH and LFOH group in vividness and emotionality rating of the mental image during height exposure. Compared to the AQ scores of LFOH groups in other studies to fear of heights (Menzies & Clarke, 1995; Steinman & Teachman, 2011), the score of the LFOH group in the present study is higher. Steinman and Teachman (2011) a low height fear group, a medium height fear group, and a high height fear group. The mean score of the LFOH group in the present study (M=31.75) is higher than the low height fear group (M=9.87) and even the medium height fear group (M=22.44) in Steinman and Teachman (2011). Thus, the LFOH group in the current study is medium afraid of heights and is therefore not representative for people with low fear of heights. Therefore, the LFOH group scores relatively high on emotionality and vividness, which decreases the chance on a significant difference between EFOH and LFOH in vividness and emotionality.

Surprisingly, the mean negativity score of the LFOH-group was significantly higher than the EFOH-group in pathway 2, see Table 3. The difference cannot be explained by differences in mental imagery ability since both pathways and groups did not differ on QMI-score. An order effect is also unlikely because negativity scores of the EFOH-group in pathway 1 are similar to the EFOH-group in pathway 2. It is the specific LFOH-group in pathway 2 that scores higher (M=65.31) on the negativity of the image than the LFOH-group

in pathway 1 (M=21.00). This difference is remarkable since this study did not find a difference in the negativity of the specific content of the image between the pathways and groups, see Appendix A. Possibly, the term negativity is too vague. It is crucial to determine whether the image is experienced as a positive or negative. However, the degree of negativity in itself (not related to emotionality) is too vague, and of subordinate interests. Therefore, future studies should only determine if the image is positive or negative.

Finally, an interaction effect between group and exposure on emotionality was found, and a trend for vividness was visible (see Figure 3 & 4). This interaction effect indicates that height exposure has an impact on emotionality (and possibly on vividness) in people with EFOH but not in people with LFOH. This result is in line with previous studies which suggest that images are specific to the individual's particular concern/fear (Pratt et al., 2004).

There are a few limitations of this study. Since this study was part of a broader research project, the VR-environments were already established and not specifically created to induce anxiety in non-clinical samples. Therefore, these VR-height environments were not sufficiently anxiety-inducing (Wuehr et al., 2019). Another limitation of the current study is the composition of the groups. Due to restriction in time, this study composed groups afterwards based on one cut-off score of the AQ. Participants could differ one point on the AQ to be regarded as EFOH or LFOH. Ideally, this study used two cut-off scores to create a "buffer zone" between the two groups; one to determine EFOH and one to determine LFOH.

Besides these limitations, this study is the first to investigate the presence and characteristics of intrusive images in EFOH. Since this study found a difference in the presence of intrusive images in everyday life of people with EFOH and LFOH, this indicates that intrusive imagery is present in acrophobia. Due to the limitations of this study, it is premature to make a concrete statement about the presence of intrusive images during height exposure. The effect of exposure on vividness in people with EFOH, indicates that mental (intrusive) imagery is present in acrophobia. However, future research into intrusive images is necessary to strengthen this statement. Ideally, future research should screen participants on acrophobia and on LFOH to create an acrophobic and an LFOH group. These groups should then be exposed to VR-height environments of at least 40 meters high. If these studies find out that people with acrophobia experience mental intrusive images that are vivid and emotional, treatments that target intrusive images (e.g. ImRs) should be considered.

APPENDIX A. *The most negative content of intrusive images during height exposure of each pathway and group.*

Pathway 1

EFOH

"That the floor of glass underneath my feet will disappear. I fall down and try to grab the bar".

LFOH

"I am standing on 15/20 meters above the ground on the second/third floor. I grab the bar, and I am looking down. I think about what could happen if I fall down".

Pathway 2

EFOH

"That the floor of glass breaks and I will fall off the bacony".

LFOH

"I am standing on the first floor. I am looking down through the floor of glass. When I set a step on the floor, I felt through it".

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