The content of mental imagery in Acrophobia: the potential of virtual reality in chartering mental imagery

Master Thesis Clinical Psychology

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Abstract

Mental imagery is a subjective experience and its antecedents and consequents are objectively observable. Mental images can be positive or negative and are often associated with emotions. One anxiety disorder in which there is little known about the content of mental imagery is acrophobia. This research aims to look at the content of the mental imagery concerning heights.

First, participants will be randomly assigned to either the low-high condition or the high-low condition. Further, participants will be exposed to different height positions in a virtual reality environment, after which they have to answer questionnaires and an interview about if they experienced mental imagery, voluntarily or involuntarily and about in which modalities and from which perspectives these were experienced.

A Chi-Square Test for Goodness of Fit was done to compare whether looking down from heights triggered the same mental imagery as looking up to heights on different variables.

All four hypotheses, about the content, voluntariness, the sensory modalities and the vividness of the mental imagery, were rejected. It is advised to do future research with a larger, more clinical sample.

Introduction

Mental imagery has been defined in a lot of different ways in the past. However, they all agree that mental imagery is a subjective experience and that its antecedents and consequents are objectively observable (Richardson, 2013). Richardson (2013) has tried to combine those definitions and says: "Mental imagery refers to all those quasi-sensory or quasi-perceptual experiences of which we are self-consciously aware, and which exist for us in the absence of those stimulus conditions that are known to produce their genuine sensory or perceptual counterparts…"

These mental images can be positive or negative and are often associated with emotions (Holmes, Mathews, Dalgleish & Mackintosh, 2006). Mental imagery can have a large effect on emotion and therefore plays an important role in emotional disorders (Holmes, Lang & Deeprose, 2009). For example, reports of problematic mental imagery related to the main fear of the patients are common in almost all anxiety disorders and can be activated by anxiety-provoking situations, or even by thinking about feared events (Hirsch & Holmes, 2007). In social phobia, for example, these images are often of the physical reactions of their anxiety like sweating or a wavering voice. And even though the images are personal experiences, the content of the imagery is generally consistent within the disorders (Hirsch & Holmes, 2007).

These images can for instance be memories of past events or daydreams of possible future events and can be voluntary or involuntary (Holmes & Mathews, 2010). People often rehearse the possible outcomes of an event in their head in order to decide what they are going to do. The outcome of these simulations can affect the mood (Sanna, 2000). Negative outcomes in these simulations often lead to avoidance of the situation. These deliberately generated images are an example of voluntary mental imagery. An example of an involuntary memory-based mental image is re-experiencing a traumatic event (Pearson, Naselaris, Holmes & Kosslyn, 2015). In this case a sensory cue from the environment matches something in the episodic memory and automatically evokes an intrusive mental image (Holmes & Mathews, 2010). The impact of these distressing images can be great. People who experience these problematic mental images often avoid situations or other factors that may trigger these images. These intrusive images affect behavior and physiology and are often maintaining the disorder.

The content of the mental imagery often matches the core concern of the patient (Pearson, Naselaris, Holmes & Kosslyn, 2015). For example, patients with social phobia are

often imagining that they look red and sweaty while talking to others. Patients with a bipolar disorder may have images of possible future events concerning suicide. And even though these mental images are most often visual, they can also be found in all other sensory modalities (Schifferstein, 2009). Schifferstein states that the visual modality plays a dominant role in mental imagery, but that mental imagery can also contain sound, feel, smell, or taste. For example, when an event elicits imagery of someone you know, you may also smell their scent. This does not mean that most mental images only consist of the visual modality, but that the visual modality is experienced most vividly. Charting the content of the mental imagery may help understanding the given disorders and may help to develop new treatments for these disorders.

One anxiety disorder in which there is little known about the content of mental imagery is acrophobia. Acrophobia is a specific phobia according to the Diagnostic and statistical manual of mental disorders (5th ed.; DSM–5; American Psychiatric Association, 2013). Among the symptoms of acrophobia are fearfulness, agitation, an upset feeling in the stomach, subjective postural instability and weakness in the knees (Brandt & Huppert, 2014). The most frequent reaction to the triggering stimuli is avoidance. The best-known mental imagery in acrophobia is the image of falling (Clerkin, Cody, Stefanucci, Proffitt & Teachman, 2009). However, Menzies & Clarke (1995) have found that patients with acrophobia already have a higher level of anxiety while standing on ground level and looking at heights than people without acrophobia. This is interesting because when the patients are standing on ground level, there is no possibility of falling from a height. It is likely that there are more mental images than the image of falling from the building. Possibly, the mental imagery might consist of more sensory modalities than only the visual. For example, people may experience feeling the wind or hear the swishing of the wind. Also, it might be possible that not all mental imagery is about future events, like falling off a building, but also about past events from their memory.

Besides the negative mental imagery, people with a fear of heights may also suffer from a perceptual bias (Dreyer-Oren, Clerkin, Edwards, Teachman & Steinman, 2019). This means that people with acrophobia might have an altered depth perception and see heights as higher than they are. This might also be a factor that maintains or triggers acrophobia.

To fully understand maintaining and triggering factors in acrophobia, it is necessary to know more about the content, modalities and qualities of the mental imagery that are involved. Therefore, the general research question of this study is what the quality of mental imagery triggered by virtual environments is in participants with elevated fear of heights.

To investigate mental imagery in elevated fear of heights, a virtual reality environment will be used to expose participants to (feared) height situations and trigger possible mental imagery. Virtual reality is a highly suited and effective instrument to investigate anxiety-related disorders (Meyerbröker & Emmelkamp, 2010), with effects generalizing to the real world (Morina, Ijntema, Meyerbröker, & Emmelkamp, 2015).

Based on the findings of Clerkin et al. (2009) and Menzies & Clarke (1995) it has been found that the most common mental image in acrophobia is the image of falling off a building. Therefore, it is expected that the mental imagery will be mainly images of possible future events, like falling off a building. So, the first hypothesis is: The mental imagery concerning heights will consist of images of the future and not images from past events.

Secondly, based on the findings of Holmes & Mathews (2010), it was found that disorders are often maintained by intrusive involuntary images. Therefore, it is expected that the mental imagery in acrophobia will be mainly involuntary. So, the second hypothesis is: The mental imagery concerning heights will be involuntary when prompted by height situations.

Thirdly, based on the findings of Schifferstein (2009), it was found that, even though mental imagery can be found in all sensory modalities, the visual modality has a dominant role in mental imagery. Because of this, it is expected that the mental images will consist of visual modalities, rather than other modalities. Therefore, the third hypothesis will be: The mental imagery concerning heights will consist of visual modalities, rather than other modalities when prompted by height situations. Also, it is expected that there will be other differences in mental imagery between looking down from a height and looking at heights while standing on ground level, since the possibility of falling is not present at that time. So, this research will also look at the differences in sensory modalities in the mental imagery when looking down from a height and looking at heights while standing on ground level.

Another difference between the mental imagery while standing on ground level and while standing on a higher place, is the level of vividness of the mental imagery. Based on the findings of Menzies and Clarke (1985) it is expected that there will be an increase in vividness of the mental imagery when participants are in a higher place. So, the fourth hypothesis is: The vividness of the mental imagery concerning heights will be higher when looking down from a height, than when looking at heights from the ground.

Methods

Participants

The study took place at Utrecht University and had received approval of the ethics committee (FETC17-103). Participants were recruited via social networks of the research assistants and were recruited as well via posters and flyers at the Campus Utrecht Science Park Uithof. To be allowed to participate in this study, participants had to be at least 18 years or older. All the participants were either students or recently graduated. Before participating, all participants were asked if they had a fear of heights. They could participate either way, but this way there would hopefully be enough participants with a fear of heights. The participants were randomly assigned to the different conditions using randomization.com. With randomly permuted blocks, participants were assigned to treatment in blocks to ensure that equal number of subjects have been assigned to each treatment each time the number of subjects is a multiple of the block size.

Procedure

When participants were recruited, they were invited to come to the laboratory at the Uithof. When they came in, they would take place behind a desk. They got a briefing about the study written on paper as well as verbally. When they had read the briefing and wanted to proceed with the study, they had to sign an informed consent. Participants were randomly assigned to either the low condition of the high condition. The low condition meant that the first VR moment would be on ground level and the second VR moment on the first and third floor. The high condition would start on the first and third floor and the second VR moment would be on ground level.

Participants started by filling in questionnaires about acrophobia, mental imagery and height intolerance. First, they had to fill in some demographics, namely age, sex, if they were pregnant, their work/study situation, highest level of education completed, if they had glasses, if they had an eye defect and if they suffered from motion sickness. After that they got their participant number. Then they had to fill in the Acrophobia Questionnaire (Cohen, 1977), Attitude Towards Height Questionnaire (Abelson & Curtis, 1989), the Questionnaire on Mental Imagery (Sheehan, 1967), the Prospective Imagery Task (MacLeod et al., 1996), Visual Height Intolerance Severity Scale (Huppert, Grill & Brandt, 2017), and an adapted version of the Plymouth interview (Hackmann, Clark & McManus, 2000; Homer & Deeprose,

2017). After these questionnaires they had to stand inside the VR area and put on the VR headset.

In the VR environment the participants started in the habituation position, where they could get used to being in the VR environment without being exposed to heights. This position was included as a manipulation check, so physiological symptoms were not caused by cyber sickness. After two minutes they were moved to either first the low condition or the high condition.

In the low condition participants stood in the foyer of the building, from which they could see all the balconies of the building. They were asked to look around and describe what they saw. Also, they were asked to look up and count the balconies, so it was sure they were exposed to the high places. After one minute they were moved to the second and last position in the low condition, which was outside on the terrace. From here the participants could look inside and see all the balconies, but they could also look up to the roof and see the full height of the building. Again, they were asked to look around, tell what they saw and to count the balconies, but additionally they were also asked to look up to the roof. After one and a half minute they were asked to remove their headset.

The first position of the high condition was on the first balcony (see picture 1). The participants stood on a glass floor in this position. They were asked to look around and describe what they saw and to look down. After one and a half minute they were moved to the second position. This was on the third and highest balcony. They were asked to look around, look over the railing and describe what they saw. They were in this position for one and a half minute and then were asked to remove their headset.

After the first VR moment, either high or low condition, the participants had to answer four VAS-scales and an interview about the mental imagery in the VR environment on the computer. When these were answered, the second VR moment started. The second VR moment was the same as the first, but in the other condition.

After the second VR moment, the participants had to fill in the same VAS-scales and interview. Last, the participants were asked if they experienced visual height intolerance in the VR. If they said yes, they had to fill in a questionnaire on visual height intolerance in relation to VR. Afterwards they got a debriefing and then they could leave.

Materials

Acrophobia Questionnaire (AQ)

To determine the presence and severity of acrophobia in the participants, the Acrophobia Questionnaire (AQ) was used (Cohen, 1977). The purpose of this questionnaire is to assess the severity of anxiety and avoidance behavior in common height situations (Antony, 2002). The AQ is a self-report questionnaire which consists of 40 items. First, the participants must rate their anxiety in 20 height related situations on a seven-point scale ranging from 0 (not at all anxious; calm and relaxed) to 6 (extremely anxious). Subsequently, the participants must rate their avoidance for the same twenty situations on a three-point scale ranging from 0 (would not avoid doing it) to 2 (would not do it under any circumstances). An example of an item of the AQ is "Sitting in a Ferris wheel". The cut-off score for the AQ, based on Steinman & Teachman (2011), was 45.45 for anxiety and for avoidance it was 8.67. These cut-off scores were used to divide the participants in two groups and compare them. Baker, Cohen & Saunders (1973) claim that the split-half reliabilities for the AQ were r = 0.82 for the Anxiety Scale and r = 0.70 for the Avoidance Scale. Also, they claim that the correlation between the Anxiety and Avoidance Scales was high (r = 0.73).

Questionnaire on Mental Imagery (QMI)

To measure the vividness of the mental imagery, the shortened version of the QMI constructed by Sheehan (1967) was used. This questionnaire, a shortened form of Betts' questionnaire upon mental imagery (Betts, 1909), is a 35-item questionnaire with seven subscales covering all sensory modalities: visual, auditory, cutaneous, kinesthetic, gustatory, olfactory and organic. For each item, the participant was asked to imagine a certain objects or situations. The items were answered on a 7-point Likert scale how vivid their images were, ranging from (1) "I perceive it perfectly clearly, as if it were real" to (7) "I think about it, but I cannot imagine it". The internal consistency of the QMI was $\alpha = .98$ (Oertel et al., 2009). Pearson et al. (2013) and Sheehan (1967) claim that the validity of the QMI is supported by a high correlation (r = .92) with the original scale by Betts (1909).

Visual Height Intolerance Severity Scale (VHISS)

The VHISS (Huppert, Grill & Brandt, 2017) is a short scale to assess the severity of visual height intolerance and acrophobia. It consists of 16 items. The first item is used to determine the lifetime presence or absence of visual height intolerance (vHI) or fear of heights. Eight questions determine the severity of the condition, how vHI restricts the individual in daily

activities and sports, and the general impairment of quality of life. The rest of the questions determine the specific triggers, bodily symptoms, frequency of occurrence, and the duration of the susceptibility and the behavioral consequences of the susceptibility. Huppert, Grill & Brandt (2017) measured the internal consistency with the person separation index (PSI), which indicates how well the scale differentiates between patients. The internal consistency of the VHISS as quantified by the PSI was 0.61. The convergent construct validity was moderate (r = 0.46), but they reported that individuals with acrophobia scored significantly higher than those without acrophobia.

Plymouth Interview

The Plymouth interview (Hackmann et al., 2001; Homer & Deeprose, 2017) is an interview about mental imagery in social anxiety. For this research, this interview was adapted to cover specific anxieties instead of social anxiety. Questions that were not applicable for specific anxiety were deleted or adapted to fear of heights. The adapted version of the interview used in this study can be seen in the appendices.

Visual analogue scale (VAS)

A VAS-scale is an instrument that can be used to measure subjective characteristics that are impossible to measure directly (Crichton, 2001). It can be used in a wide variety of research domains. The VAS-scale consists of a horizontal line with word descriptors at the left and the right side of the line. The participant marks the place on the line which represents their state the most. Such an assessment is subjective and is best used to look at change within a person (Crichton, 2001). Because feelings are subjective, they are impossible to analyze absolutely and therefore validation of this instrument regarding measuring feelings is difficult. So, as far as assessing the psychometric values is possible, the construct validity seems to be good, as well as the internal consistency (Aitken, 1969). Ahearn & Carroll (1996) found that the test-retest reliability of the VAS is $r = 0.82$. Davies, Burrows & Poynton (1975) found that the validity of the VAS lies between $r = 0.65$ and $r = 0.62$.

VR equipment and

The VR headset that was used was an Oculus Rift CV1 with to Oculus trackers. The computer on which the software was run had an Intel i5 7600 3.5GHz processor, an 8GB RAM, a 256GB (nvme) SSD hard disk, a GTX 1060 6GB video card and used Windows 10 x64. The

VR project was developed in Unity3d (release 2018.2.13f1). To run the VR environment, the Oculus software was used.

VR environment

The VR environment was a replica of the Muziekgebouw aan ‘t IJ, a concert building in Amsterdam. There were 5 positions in the VR environment. Two positions in the low condition, two positions in the high condition and one habituation position.

The habituation position was on ground level, beneath the first balcony. The participants could get used to the VR environment without being exposed to heights, because of the low ceiling.

The first position in the low condition was also on ground level, but in the foyer instead of beneath the balcony. In the foyer, the participants could look up to all three balconies of the building.

The second position of the low condition was also on ground level, but on the terrace outside of the building. From the terrace, the participants could see all three balconies through the glass walls, but they could also look op to the overhang of the roof.

The first position of the high condition was on the first balcony of the building. Participants stood on a glass floor next to a glass wall. This way the participants could experience the height very well.

The second position of the high condition was on the third and highest balcony of the building. The participants stood at the railing of the balcony and were asked to look down over the railing.

Study design

The study concerned a randomized controlled cross-over design trial. The group was randomly divided in two groups. The first half of the group participated in the low condition in the first VR moment, and the high condition in the second VR moment. The other half of the group did the opposite: they participated in the high condition in the first VR moment, and in the low condition in the second VR-moment.

Data Analysis Plan

First, a Chi-Square Test for Goodness of Fit was conducted to determine whether participants chose “a future situation” more often when asked what their mental images depicted when

exposed to heights. The variables in this analysis were “depiction of mental imagery” and the frequency of the chosen answers.

Secondly, for the scores on the VAS-scale for voluntary versus involuntary imagery will be split in two groups with a cut-off of 5. Participants with a score below 5 will have scored involuntary and participants with a score above 5 will have scored voluntary. A Chi-Square Test for Goodness of Fit was used to determine if the imagery was more often deemed voluntary or involuntary. The variables used in this analysis were “voluntary vs. involuntary” and the frequency.

Thirdly, a Chi-Square Test for Goodness of Fit was used to determine if one of the senses was chosen more often by participants, when asked which senses were involved in the mental imagery when exposed to heights. The variables in this analysis were “the senses” and the frequency of the chosen answers.

The fourth hypothesis was tested by conducting a paired sampled t-test on the mean scores on the VAS-scales for the vividness and how detailed it was, to determine if the vividness and the degree of detail was scored higher in the height condition than in the depth condition. The dependent variables were the mean VAS-scores and the independent variable was the height/depth condition.

All analyses were done using version 25 of IBM SPSS Statistics.

Results

The final sample consisted of 23 participants (14 women and 9 men) with an average age of M = 23 and a standard deviation (SD) of 1.93. Twenty of the participants were students, the other three were working. Of the 23 participants, 10 had finished an academic education, 9 had finished pre-university education, 2 had finished Senior General Secondary Education and 2 had finished University of Applied Sciences (see table 1 for an overview). Using the AQ as indication with a cut-off score of 45.45, 9 participants scored high on the anxiety scale of the AQ and 12 participants scored low. Two participants did not get a score because of missing values. Using a cut-off score of 8.67, all the participants, minus the two with missing values, scored high on the avoidance scale of the AQ.

Table 1

Demographics

Variable	**Total (N = 23)**
Sex	
Male	14
Female	9
Age	23; 1.93 (M; SD)
Work/study situation	
Studying	20
Working	3
Highest level of education completed	
Senior General Secondary Education	2
Pre-university education	9
University of Applied Sciences	2
Academic education	10
Eye deviation	
Near-sighted	8
None	15

Baseline equivalence of groups

To check if the different conditions, the low versus the high condition and the high versus the low condition, were not significantly different, an independent sample t-test was conducted to see if the AQ anxiety and avoidance scores were not significantly different for the two groups. For the AQ anxiety score, there was no significant difference in the low-vs-high group (M = 43.6, SD = 13.3) and the high-vs-low group (M = 46.4, SD = 2.3); t (19) = -.44, p = 0.664.

For the AQ avoidance score, there was no significant difference in the low-vs-high group (M = 25.7, SD = 3.8) and the high-vs-low group (M = 23.8 SD = 16.4); t (19) = 1.33, p = 0.198. This indicates that the groups did not significantly differ in the scores on the AQ scales. See table 2 and 3 for the overview.

Table 2

The group statistics of the two groups for the wo subscales of the AQ

	Condition	**N**	**M**	**SD**	**Std. Error Mean**
Anxiety_AQ	Low_vs_high	12	43.6	13.3	3.8
	High_vs_low	9	46.4	16.4	5.5
Avoidance_AQ	Low_vs_high	12	25.7	3.8	1.1
	High_vs_low	9	23.8	2.3	0.8

Table 3

The results of the independent samples t-test

	t	**Df**	**Sig. 2-tailed**	**Mean Difference**	**Std. Error Difference**
Anxiety_AQ	-.442	19	.664	-2.86	6.48
Avoidance_AQ	1.333	19	.198	1.89	1.42

First hypothesis: Mental imagery concerning heights consist of images of the future and not images from past events

Because the items were nominally scaled and the used sample was small, a non-parametric test was chosen. A Chi-Square test was conducted twice. Once for before the VR moments and once for after the VR moments. The Chi-Square test for before the VR moment was not significant, χ^2 (2, N = 10) = .20, p = .905, with a Cohen's *w* of 0.14, which can be considered small. See table 4 for the results of the item before the VR moments.

Table 4

The results of the item "Is the image a reflection of", before the VR-moments

	Observed N	**Expected N**	**Residual**
A moment when you felt anxious in a situation where you were exposed to altitude.	3	3.3	-.3

A future situation where you are exposed to altitude.	4	3.3	.7
None of the above, the image is not a reflection of fear.	3	3.3	-.3
Total	10		

The Chi-Square test for after the VR moment was also not significant, χ^2 (2, N = 8) = 3.25. p = .197, with a Cohen's *w* of 0.64, which can be considered large. See table 5 for the results of the item after the VR moments.

Table 5

The results of the item "Is the image a reflection of", after the VR-moments

	Observed N	**Expected N**	**Residual**
The moment when you felt anxious in the VR situation?	2	2.7	-.7
A future situation where you are exposed to altitude.	1	2.7	-1.7
A general situation where you are exposed to altitude, which makes you or might make you anxious?	5	2.7	2.3
Total	8		

Second hypothesis: The mental imagery concerning heights will be involuntary when prompted by height situations.

For the second hypothesis, the participants were split in two groups, namely "voluntary imagery" and "involuntary imagery". In the low condition 11 participants scored "involuntary" and 5 participants scored "voluntary". In the high condition, 6 participants scored "involuntary" and 7 participants scored "voluntary".

Again, a non-parametric test was chosen, because the items were nominally scaled, and the used sample was small. A Chi-Square Test was conducted twice. Once for the low condition and once for the high condition. For the low condition, the Chi-Square test was not significant, χ^2 (1, N = 16) = 2.250, p = .134. This indicates that in the low condition none of the options was chosen significantly more often than others. See table 6 for the results of the item in the low condition.

Table 6

The results of the item "To what extent are the images you had voluntarily / involuntarily?" in the low condition.

	Observed N	**Expected N**	**Residual**
involuntary	11	8	3.0
voluntary	5	8.0	-3.0
Total	16		

For the high condition, the Chi-Square test was also not significant, χ^2 (1, N = 13) = .077. p = .782. This indicates that in the high condition none of the options was chosen significantly more often than others. See table 7 for the results of the item in the high condition.

Table 7

The results of the item "To what extent are the images you had voluntarily / involuntarily?" in the high condition.

	Observed N	**Expected N**	**Residual**
involuntary	6	6.5	-.5
voluntary	7	6.5	.5
Total	13		

Third hypothesis: The mental imagery concerning heights will consist of visual modalities, rather than other modalities when prompted by height situations.

Again, a non-parametric test was chosen, because the items were nominally scaled, and the used sample was small. A Chi-Square test was conducted twice. Once for before the VR moments and once for after the VR moments. Because only one participant answered the item after the low condition, it was decided not to compare the low condition and the high condition. In the case of before the VR moments, the Chi-Square test was not significant, χ^2 (5, N = 38) = 1.158, p = .949. This indicates that before the VR moments, none of the options was chosen significantly more often than others. Cohen's *w* was 0.17, which can be considered small. See table 8 for the results of the item for before the VR moments.

Table 8

The results of the item "Which senses are involved in your image?", before the VR-moments

	Observed N	**Expected N**	**Residual**
Sight	7	6.3	.7
Hearing	7	6.3	.7
Smell	5	6.3	-1.3
Taste	5	6.3	-1.3
Touch	6	6.3	-.3
Feel	8	6.3	1.7
Total	38		

In the case of after the VR moments, the Chi-Square test was not significant, χ^2 (2, N = 11) = 3.455. p = .178. This indicates that after the VR moments, none of the options was chosen significantly more often than others. Cohen's *w* was 0.56, which can be considered large. See table 9 for the results of the item for after the VR moments.

Table 9

The results of the item "Which senses are involved in your image?", after the VR-moments

	Observed N	**Expected N**	**Residual**
Sight	4	3.7	.3
Hearing	1	3.7	-2.7
Feel	6	3.7	2.3
Total	11		

Fourth hypothesis: The vividness of the mental imagery concerning heights will be higher when looking down from a height, than when looking at heights from the ground.

A paired samples t-test with an α of .05 was conducted to compare the mean VAS-score on the vividness of the mental imagery in the depth condition (M = 6.57, SD = 2.98) to the mean VAS-score in the height condition (M = 7.07, SD = 1.59). The difference was found to be non-significant, $t(13) = -.58$, $p = .575$. The same was done for the mean VAS-scores on the degree of detail of the mental imagery in the depth condition (M = 5.50, SD= 2.68) and the height condition (M = 6.07, SD = 2.24). Again, the difference was found to be non-significant, $t(13) = -.59$, $p = .566$.

Discussion

The aim of the current study was to investigate the content of the mental imagery concerning heights. It was found that the mental imagery did not depict possible future events more frequently than memory-based events or general events concerning heights. Secondly, the mental imagery was not deemed involuntary more often than voluntary. Thirdly, it was found that the mental imagery concerning heights did not consist of one sensory modality more than the other sensory modalities. Finally, it was found that looking down from a height does not elicit more vivid and detailed mental imagery than standing on ground level while looking up to a height.

To test the first hypothesis, participants were asked what their mental images depicted. Participants only had to answer this question after the VR moments if they indicated that they had experienced mental images during the VR moments. Because only two participants with a low anxiety score answered this question, it was decided to just look at the whole group and not divide them into high anxiety and low anxiety. A Chi-Square Test for Goodness of Fit was conducted to determine whether participants chose one answer more often than the other answers. In both cases, before and after the VR moments, the Chi-Square test was non-significant. Contrary to our findings Clerkin et al. (2009) and Menzies & Clarke (1995) stated that the most common mental image in acrophobia is the image of falling off a building. In this study it was found that none of the options was chosen significantly more often than the others. Therefore, the first hypothesis is rejected. However, all the participants scored high on the avoidance scale of the AQ. Possibly, some participants answered that they did not experience mental imagery after the VR moments, either conscious or unconscious, as avoidance behavior. This could distort the results. Also, not all the participants understood the term ‘mental imagery’ and asked the researcher for help. Possibly, the definition of mental imagery that was given was not clear enough.

The second hypothesis was tested using a Chi-Square Test for Goodness of Fit to determine whether the mental imagery was more often deemed involuntary or voluntary. This was done for the low condition and the high condition. In both cases it came out non-significant, meaning that in both conditions the mental imagery was deemed neither voluntary of involuntary more often than the other. Because Holmes & Mathews (2010) found that disorders are often maintained by intrusive involuntary images, it was expected that the mental imagery concerning heights would also be involuntary. The findings do not match this

hypothesis, which is therefore rejected. This could be explained by the fact that the participants in the used sample might not suffer from any disorders, but simply have a fear of heights or nothing at all. So maybe the mental imagery for these participants were not strong enough to be deemed involuntary. Also, a VAS-scale might not be the right instrument to assess whether the mental imagery is voluntary or involuntary. In this study, participants could answer on a scale from zero to ten. It might be better to just give the options 'voluntary' and 'involuntary', so the answers are clearer.

The third hypothesis was tested using Chi-Square Test for Goodness of Fit to determine whether one of the sensory modalities was chosen more often than the other senses. Like with the first hypothesis, this was done before the VR moments and after the VR moments. Again, it was non-significant in both cases, indicating that none of the senses was chosen significantly more often than the others. Schifferstein (2009) had found that most mental imagery is visual, even though mental imagery can be found in all sensory modalities. Therefore, it was expected that this would also be the case in the mental imagery concerning heights. As the results do not match this hypothesis, the third hypothesis is rejected. An explanation might be that there are more sensory modalities that play a role in the same mental imagery. For example, when one experiences mental images about falling off a building, they might also feel and hear the wind.

Using a paired samples t-test, the fourth hypothesis was tested. This was done by the mean VAS-scores for the degree of vividness and detail in the mental imagery. This was measured after both the first and second VR moment. Both the difference in vividness and the degree of detail in mental imagery was non-significant. This indicates that looking down from a height does not elicit more vivid and detailed mental imagery than when standing on ground level while looking up to a height. According to Menzies & Clarke (1995), patients with acrophobia already have a higher level of anxiety while standing on ground level and looking at heights than people without acrophobia. It was expected that this would only increase when standing on a height. However, the results do not match this hypothesis, which is therefore rejected. Possibly, there is no difference between looking up to a height and looking down from a height for people with acrophobia. Some participants expressed that they were not scared to look down, but got dizzy when they looked up to heights. So maybe there is no difference between the two situations. Or maybe there are two different types of acrophobia, where some people are scared to look up to heights and some people are scared to look down from heights. Whether or not the mental imagery is experienced as more vivid might be dependable on which situation is scarier to someone.

There are a few additional limitations in this study that might have contributed to the fact that all four of the hypotheses were rejected. Rejecting all hypotheses would indicate that there are no visible trends in the mental imagery concerning the depiction of the future or the past, voluntariness, sensory modalities and the vividness. Even though this could be the case, there are also a few factors that might have intervened.

First of all, the questionnaires often were set up in such a way that when a participant answered "no" to a question, then the participant had to skip a lot of questions. Because of this, a lot of participants did not answer the items that were necessary for the analyses. Future research might want to use another questionnaire or adjust the current questionnaires to make them fit for this research.

Another factor that might have influenced the outcome, is that all the participants had high score on the avoidance subscale of the AQ. Possibly, the participants were unable or unwilling to talk about the mental imagery that was evoked in the VR environment because of their avoidance behavior. Pearson, Naselaris, Holmes & Kosslyn (2015) stated that people often avoid the reminders of their fear. Talking about the experienced mental imagery might also be something they want to avoid. Future research in the mental imagery of acrophobia might want to this avoidance into account. An option might be to make all the items forced response items, so the participants can not avoid by not answering. Another option might be to do the assessment in a oral interview, so the interviewer can ask further when the participant is avoiding.

A third factor was the used sample. The used sample was small and consisted of both participants that claimed to have a fear of heights and participants who claimed they did not have a fear of heights. It might be wise, for future research, to use a larger sample with more participants that suffer from a fear of heights. People who do not suffer from a fear of heights might not experience mental imagery or the mental imagery might be less vivid.

It is advised that in future research, a larger sample is used. Preferably, this sample consists of people that are diagnosed with acrophobia or visual height intolerance, so that it is more likely that mental imagery will be experienced. Also, the questionnaires have to be changed, so that participants cannot skip items. This, to make sure that as much data as possible is gathered and the participants cannot avoid. And last, the participants might need more help in describing their experienced images. For a lot of participants, it is a new concept, so putting it into words might be difficult. This might be helped if this was done in an oral interview, but maybe a more elaborate instruction in the computer questionnaires may be enough. Despite this, the usage of a VR environment in evoking mental imagery looks

promising. Almost all participants expressed their disbelief in how well the depth perception was and that they really felt they were looking down from a height. So, a follow up is definitely recommended.

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Appendices

A. The mental imagery interview before VR-moment

Wanneer u mentale beelden heeft, wil dit zeggen dat u een beeld voor ogen heeft, zelfs wanneer dit beeld niet fysiek aanwezig is. Mentale beelden kunnen de vorm aannemen van een beeld van uzelf, een beeld van andere mensen, of een beeld van een specifieke plaats of tijd. Ook specifieke herinneringen of mogelijke toekomstige gebeurtenissen kunnen onderdeel zijn van mentale beelden.

Mentale beelden worden negatief genoemd wanneer ze onplezierig zijn, of wanneer ze onplezierige gevoelens oproepen, zoals stress of angst. Mentale beelden kunnen 'terugkerend' genoemd worden wanneer u ze meer dan eens heeft ervaren. Mentale beelden kunnen 'onvrijwillig' genoemd worden wanneer ze op willekeurige momenten in uw hoofd opkomen, zelfs wanneer u dit niet wilt.

1. Heeft u ooit negatieve mentale beelden ervaren met betrekking tot hoogte die terugkerend EN/OF onvrijwillig zijn? Dit zou bijvoorbeeld het herbeleven van een bepaalde herinnering kunnen zijn, of dat u een beeld van u zelf ervaart waarin u uzelf ziet reageren op een moment dat u hoogtevrees ervaart.
    - Ja
    - Nee/ik weet niet zeker
2. Beschrijf het beeld zo gedetailleerd mogelijk in uw eigen woorden.
3. Probeer te denken aan een moment waarop u zich erg angstig voelde toen u in aanraking kwam met hoogte. Probeer de herinnering in uw eigen woorden te beschrijven.
4. Hoe vaak ervaart u een dergelijk beeld? Kies één van onderstaande mogelijkheden.
    - Elke dag, of bijna elke dag
    - Om de paar dagen
    - Ongeveer een keer per week
    - Ongeveer een keer per paar weken
    - Ongeveer een keer per maand
    - Minder dan een keer per maand
    - Anders, namelijk:

5. Wanneer komt dit beeld meestal voor? Vink alle mogelijkheden aan die op u van toepassing zijn.
    - Elke dag of bijna elke dag, ongeacht wat ik aan het doen ben
    - Op dagen waarop ik in een negatieve stemming ben
    - Vlak voordat ik mijn huis verlaat
    - Vlak voordat ik in een situatie kom waarin ik misschien in aanraking kom met hoogte
    - Vlak voordat ik in een situatie kom waarin ik zeker weten in aanraking kom met hoogte
    - Tijdens dat ik in aanraking kom met hoogte
    - Nadat ik in aanraking gekomen ben met hoogte
    - Op willekeurige momenten
    - Anders, namelijk:
6. Is het beeld dat u heeft gebaseerd op de herinnering aan een specifieke gebeurtenis? Als dit het geval is, beschrijft u de herinnering dan hieronder. Als dit niet het geval is, beschrijft u dan mits dit mogelijk is waar het beeld vandaan komt.
    - JA, mijn beeld is gebaseerd op een specifieke herinnering. Beschrijft u deze herinnering.
    - NEE, mijn beeld is niet gebaseerd op een herinnering. Beschrijft u waar het beeld op gebaseerd is.
7. Is het beeld een afspiegeling van: (Er zijn meerdere antwoorden mogelijk)
    - Een moment waarop u zich angstig voelde in een situatie waarin u in aanraking kwam met hoogte.
    - Een toekomstige situatie waarin u in aanraking komt met hoogte.
    - Een algemene situatie waarin u in aanraking komt met hoogte.
    - Geen van bovenstaande, het beeld is geen afspiegeling van angst.
8. Is het beeld in het eerste-persoonsperspectief of het derde-persoonsperspectief? Met het eerste-persoonsperspectief wordt bedoeld dat u vanuit uw eigen oogpunt kijkt naar iets of iemand anders. Met het derde-persoonsperspectief wordt bedoeld dat u vanuit iemand anders' oogpunt of als observator naar uzelf kijkt. Wanneer u twijfelt, welk perspectief kunt u zich makkelijker voorstellen?
    - Eerste persoon
    - Derde persoon

9. Welke zintuigen zijn betrokken bij uw beeld? Beschrijf per zintuig een of twee woorden om uw ervaring te beschrijven.
    - Ik zie ...
    - Ik hoor ...
    - Ik ruik ...
    - Ik proef ...
    - Ik raak ... aan
    - Ik voel
10. Probeer vanaf nu te concentreren op de VISUELE-aspecten van de herinnering uit de VR-wereld (wat kunt u zien)? Negeer de andere zintuigen. Als uw beeld geen visuele aspecten heeft, probeert u zich dan in te beelden hoe deze eruit zouden zien. Bijvoorbeeld, wanneer u alleen knikkende knieën heeft, focus u dan op hoe dat eruit zou zien (bijvoorbeeld, heen en weer wiebelen op de hoogste verdieping van het muziekgebouw).

    Beschrijf uw beeld.
11. Wat voor een gevoel geeft het beeld u?
    VAS-schaal 1: Angstig/nerveus van 0 tot 10
    VAS-schaal 2: Anders namelijk... van 0 tot 10
    Heeft u het gevoel dat het beeld dat u beschreven heeft een kloppende representatie is van uw angst in een situatie waarin u in aanraking komt met hoogte, zoals in de VR-omgeving?

    (VAS-schaal)

    0 = helemaal niet representatief

    100 = zeer representatief
12. Het is de bedoeling dat u zo dadelijk een duidelijk visueel beeld oproept van een negatieve situatie waarin u in aanraking komt met hoogte. Probeer twintig seconden uw beeld te visualiseren. Roep het beeld zo levendig (sterk en duidelijk) naar voren als mogelijk is, en houdt dit in uw gedachten vast. Concentreer u op wat u kunt zien, hoe levendig dit is en welk gevoel dit bij u oproept.
    Wanneer u er klaar voor bent, klik dan op onderstaande knop om verder te gaan.

1. Als u terug denk aan het beeld wat u net opgeroepen hebt, ...

    VAS-schaal 1: Hoe levendig was uw beeld tijdens de visualisatie?

    VAS-schaal 2: Hoe emotioneel werd u van het beeld tijdens de visualisatie?

    0 = helemaal niet

    100 = zeer

B. The mental imagery interview after VR-moment

2. U bent net terecht gekomen in een virtuele omgeving. Denkt u terug aan het moment dat u op de hoogte stond of daarnaar hebt gekeken. Probeer de herinnering in uw eigen woorden te beschrijven. Wat voelde en dacht u op dat moment?
3. Heeft u tijdens de VR-beleving negatieve mentale associaties gehad?
    - Ja
    - Nee/Ik weet het niet zeker
4. Beschrijf de associatie in uw eigen woorden.
5. Is het beeld een afspiegeling van: (Er zijn meerdere antwoorden mogelijk)
    - Het moment waarop u zich angstig voelde in de VR-situatie?
    - Een toekomstige situatie waar u in aanraking komt met hoogte?
    - Een algemene situatie waar u in aanraking komt met hoogte, waar uw angstig van wordt of zou kunnen worden?
    - Geen van de bovenstaande. Het beeld is geen afspiegeling van angst.
6. Welke zintuigen zijn betrokken bij uw beeld? Beschrijf per zintuig een of twee woorden om uw ervaring te beschrijven.
    - Ik zie ...
    - Ik hoor ...
    - Ik ruik ...
    - Ik proef ...
    - Ik raak ... aan
    - Ik voel
7. Probeer vanaf nu te concentreren op de VISUELE-aspecten van de herinnering uit de VR-wereld (wat kunt u zien)? Negeer de andere zintuigen. Als uw beeld geen visuele aspecten heeft, probeert u zich dan in te beelden hoe deze eruit zouden zien. Bijvoorbeeld, wanneer u alleen knikkende knieën heeft, focus u dan op hoe dat eruit zou zien (bijvoorbeeld, heen en weer wiebelen op de hoogste verdieping van het muziekgebouw).
   Beschrijf uw beeld.
8. Heeft u het gevoel dat het beeld dat u beschreven heeft een kloppende representatie is van uw angst in een situatie waarin u in aanraking komt met hoogte, zoals in de VR-omgeving?
   (VAS-schaal)

0 = helemaal niet representatief

100 = zeer representatief

Het is de bedoeling dat u zo dadelijk een duidelijk visueel beeld oproept van een negatieve situatie waarin u in aanraking komt met hoogte. Probeer twintig seconden uw beeld te visualiseren. Roep het beeld zo levendig (sterk en duidelijk) naar voren als mogelijk is, en houdt dit in uw gedachten vast. Concentreer u op wat u kunt zien, hoe levendig dit is en welk gevoel dit bij u oproept.

Wanneer u er klaar voor bent, klik dan op onderstaande knop om verder te gaan.

9. Als u terug denk aan het beeld wat u net opgeroepen hebt, ...

   VAS-schaal 1: Hoe levendig was uw beeld tijdens de visualisatie?

   VAS-schaal 2: Hoe emotioneel werd u van het beeld tijdens de visualisatie?

   0 = helemaal niet

   100 = zeer