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Conquer Fear Of Heights Using Virtual Reality Exposure Therapy With Cognitive Restructuring

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Abstract

Acrophobia has traditionally been treated using exposure therapy; however, virtual reality technology has emerged as an alternative that minimizing security risks by presenting three-dimensional stimuli. This study aimed to investigate virtual reality exposure therapy-cognitive restructuring (VRET-CR) effectiveness in reducing acrophobia symptoms. In a pretest-posttest control group design, 27 participants were randomly assigned to the experimental group (n=13) and the control group (n=14). An independent sample t-test revealed a significant differences in the gain scores of the acrophobia questionnaire (AQ) 1 [t (17.08) = -6.173; p <0.05] and AQ 2 [t (25) = -4.250; p <0.05] between these groups. Scores on the State-Trait Anxiety Inventory (STAI) and Autonomic Perception Questionnaire (APQ) decreased after six exposure sessions, supporting these findings. Skin conductance and respiratory rate changes during therapy were less significant than heart rate changes. Overall, the results demonstrated the effectiveness of VRET-CR in reducing acrophobia symptoms.

Keywords: acrophobia; cognitive restructuring; virtual reality exposure therapy

Being in a high place might not significantly bother some individuals. However, it's a different story for those experiencing acrophobia, an irrational and excessive fear of heights (Milosevic & McCabe, 2015). Height-related situations can trigger unpleasant physiological effects, such as difficulty in breathing, dizziness, and even panic attacks for those with acrophobia (Syeda Sarah & Kiran, n.d.). Consequently, individuals with acrophobia tend to avoid activities involving heights, such as climbing cliffs, walking on bridges, or taking elevators (Milosevic & McCabe, 2015)

On the other hand, the increasing population and rising land prices in urban areas have led to a surge in tall building construction (Vitriana, 2017). In Indonesia, over 100 buildings with heights exceeding 150 meters have been recorded, with this number expected to increase in the coming years (skyscrapercenter, n.d.). This ongoing urban development poses challenges to the mobility of individuals, particularly those with acrophobia, potentially impacting their careers as well (Kulkarni et al., 2020).

Acrophobia is a specific phobia characterized by extreme and persistent fear or irrational anxiety towards specific situations or objects (Association, 1994). Among all specific phobia categories, acrophobia has the highest prevalence rate, approximately 4.9% (Depla et al., 2007). Global studies indicate that the prevalence of specific phobias ranges from 3% to 15% (Eaton et al., 2018). Prevalence rates also differ by gender, with lifetime prevalence of acrophobia being 8.6% for women and 4.1% for men ().

Symptoms of acrophobia involve behavioral, cognitive, and physiological changes when confronted with height-related stimuli (Huweler et al., 2009). Individuals with acrophobia tend to have biased interpretations and assessments of height-related stimuli, exaggerating potential dangers or doubting their ability to cope with anxiety in such situations (Menzies & Clarke, 1995). Many individuals with acrophobia experience catastrophic fantasies, which are inaccurate and negative thoughts about uncertain future events (Boudewyns, 1983).

Several interventions have proven effective in addressing acrophobia symptoms, including novel imaginal interventions adapted from neurolinguistic programming (Arroll et al., n.d.), pharmacotherapy (), and hypnotherapy (Hirsch, 2018). Among these, exposure therapy is reported as the most effective intervention (Eaton et al., 2018). Exposure therapy can be conducted through imagery, where individuals imagine themselves in height-related situations, or in-vivo, where individuals are directly exposed to height-related stimuli (Koerner & Fracalanza, 2012). However, in-vivo exposure can be risky for individuals with specific conditions like pregnancy, heart problems, or unexpected comorbidities. Imagery techniques can also be challenging without adequate cognitive abilities (Maples-Keller et al., 2017).

In order to overcome the limitations of exposure therapy, recent research has explored the use of virtual reality (VR) technology in therapy, known as Virtual Reality Exposure Therapy (VRET) (Brahnam & Jain, 2011). VR creates three-dimensional artificial environments, immersing users in lifelike settings (Zhang et al., 2020). VRET allows therapists to develop controlled simulations based on everyday life scenarios (Ferrer-Garcia et al., 2019). It offers advantages like ease of customization, safety, and real-time monitoring of clients during exposure (Robillard et al., 2011).

VRET has been widely used to address various psychological issues, including specific phobias such as arachnophobia (Gracia-Palacios et al., 2002) and dental phobia (Zhao et al., 2023). Additionally, recent research by Rimer et al. (2021) found that clinicians' attitudes towards Virtual Reality Exposure Therapy (VRET) for fear of heights became more positive after trying VRET themselves. Combining VRET with cognitive behavioral therapy (CBT) has been found to enhance its effectiveness, as cognitive distortions and irrational beliefs often underlie anxiety disorders (). One CBT technique, cognitive restructuring (CR), encourages individuals to identify, evaluate, and modify irrational thoughts related to their psychological disorders (Clark, 2014).

Virtual reality exposure therapy (VRET) employs immersive 360° computer-generated simulations akin to conventional exposure therapies (Lindner et al., 2020). VRET functions on the premise of the emotional processing theory, proposing that exposure therapy fosters the development of new memory structures to replace those linked with anxiety triggers (Foa & Kozak, 1986). During exposure, habituation occurs alongside corrective learning, leading to emotional restructuring (Baker et al., 2010).

Fear and anxiety involve physiological changes, primarily driven by the sympathetic nervous system (Carlson, 2013). The sympathetic nervous system becomes active when the body needs energy, triggering the fight or flight response (Shiota & Kalat, 2012). It causes increased heart rate (Carlson, 2013), increased sweating (Shiota & Kalat, 2012), and heightened alertness when an individual feels surprised, frightened, anxious, or tense (Carlson, 2013).

To observe these physiological responses, specialized instruments are used through biofeedback, a technique that measures various physiological responses such as brainwave patterns, heart rate, blood pressure, skin temperature, and muscle tension (Sundel & Sundel, 2005). These instruments include electroencephalography (EEG), electromyography (EMG), electrocardiography (ECG), and skin conductance monitors (Rakel, 2017).

Utilizing VRET in combination with CR (VRET-CR) aims to desensitize individuals with acrophobia to height-related stimuli and help them evaluate irrational thoughts about heights. Research on psychological interventions for acrophobia, especially in Indonesia, is limited, and the use of VR technology is relatively new. Therefore, empirical evidence is crucial to validate the effectiveness of VRET-CR through the assessment of developed modules. The hypothesis of this research is that the Virtual Reality Exposure Therapy - Cognitive Restructuring (VRET-CR) module is effective in reducing acrophobia symptoms.

1. Method

1.1 Research Design

The method employed in this research entails conducting experiments within a meticulously controlled laboratory setting. This approach ensures that the researchers have a high degree of control over the variables involved, minimizing the influence of external factors that could potentially confound the results. The research design adopted for this study is the Pretest-Posttest Control Group Design (Shadish et al., 2002). To mitigate potential threats to internal validity. standardized protocols for the administration of the virtual reality therapy intervention have been established, and therapists administering the intervention have undergone rigorous training to ensure adherence to these protocols. Furthermore, detailed descriptions of participant inclusion criteria were provided to ensure the representativeness of the sample. Efforts were made to recruit a diverse sample reflecting the broader population with acrophobic symptoms, thereby enhancing the external validity of our findings and supporting the generalizability of the intervention to a wider audience.

1.2 Reseach Participants

Participants for this research were recruited utilizing a combination of online platforms (such as WhatsApp, Instagram, Line, and Telegram) and offline avenues (the distribution of research posters). The inclusion criteria for participants in this study encompassed specific parameters: individuals aged between 19 and 60 years, the absence of preexisting risk-associated medical conditions (e.g., cardiovascular diseases, asthma, hypertension), the absence of concurrent comorbid mental disorders, possession of acrophobia questionnaire scores within the range of 64 to 108, non-pregnant status, and a willingness to provide informed consent. The treatment sessions were conducted offline in a laboratory research setting, where participants attended in person.

The total participant pool for this study consisted of 27 individuals, who were subjected to a randomized allocation process, dividing them into two distinct groups: the experimental group (N=13) and the control group (N=14). The experimental group received treatment in the form of Virtual Reality Exposure Therapy with Cognitive Restructuring (VRET-CR), while the control group received no form of treatment.

1.3 Materials

The materials used in this research include the VRET-CR module, virtual reality environment, biofeedback, and psychological scales. The VRET-CR module was constructed by adapting the VRET module developed by Leaman et al. (2013) for the treatment of combat-related PTSD, consisting of nine sessions with exposure starting from the third session. In this study, an additional supportive technique, cognitive restructuring, was incorporated into the exposure sessions, following the approach utilized in the study by Botella et al. (1998).

The exposure to height-related stimuli was conducted during sessions three through eight. A Vive Pro Eye HMD (Figure 1) was employed in this study. This device displayed a three-dimensional high-altitude environment (Figure 2), which encompassed the progression from an elevator stimulus ascending a tall building to a final scene atop the building, featuring a bridge plank that participants traversed. It is important to note that this virtual environment has been validated, achieving an Aiken's V coefficient of 0.76. See Figure 1 and Figure 2

Figure 1
Vive Pro Eye HMD

Figure 2
Three-dimensional High-altitude Environment

The biofeedback equipment utilized in this research is the ProComp5 Infiniti, developed by Thought Technology Ltd (refer to Figure 3). The ProComp5 Infiniti serves as a diagnostic tool, and specifically in this study, it is employed to measure heart rate, skin conductance, and respiratory rate. Data collected from sensors attached to the participants (see Figure 4) are then transmitted to a computer via fiber optic cables. The software used for processing the received signals is the BioGraph Infiniti Software V6.0, also developed by Thought Technology Ltd.

Figure 3
Biofeedback ProComp5 Infiniti

See Figure 5.

Figure 4
Sensor Heart rate, Skin Conductance, Respiratory rate

The Acrophobia Questionnaire (AQ) scale is employed to assess the severity of anxiety (20 items) and avoidance tendencies (20 items) related to 20 different high-altitude situations. Response options range from 0 (not anxious/does not avoid at all) to 6 (very anxious/avoids a lot). The results of the validity test indicate that all items are valid, with an average Aiken's V coefficient of 0.867, falling within the range of 0.6 to 0.975. Regarding reliability testing, a coefficient of 0.936 was obtained, which surpasses the acceptable threshold of 0.5. This demonstrates that the scale exhibits a high level of internal consistency

The State-Trait Anxiety Inventory (STAI) is used to assess and measure anxiety symptoms in individuals, and it was developed by Spielberger. The scale consists of 20 items that measure state anxiety (STAI form Y-1) and 20 items for trait anxiety (STAI form Y-2). In this study, only STAI form Y-1 was used. Response options range from 1 (not anxious at all) to 4 (very anxious). The scale has been translated into Indonesian. The validity coefficient is substantial, with a value of 0.920625, falling within the coefficient range of 0.875 to 1. This suggests that the scale is a valid measure of state anxiety in the context of your study. In terms of reliability, the coefficient is 0.920, which exceeds the acceptable threshold of 0.5.

The Automatic Perception Questionnaire (APQ) consists of 24 graphical scale items, each related to the perception of bodily activities across seven areas of bodily reactions: heart rate, sweating, temperature changes, respiration, digestive disturbance, muscle tension, and blood pressure. The scale is divided into 6 equal intervals, and participants are asked to score each item from one to seven. The average Aiken's V validity coefficient for this scale is 0.835, with a coefficient range from 0.461 to 1. In terms of reliability, the test's coefficient is 0.960, which is well above the acceptable threshold of 0.5.

1.4 Therapy Procedure

The experiment spanned a period of two months, from September to October. During this time, participants engaged in a series of 9 therapy sessions as part of the research study. These sessions commenced after obtaining ethical clearance from the Research Ethics Committee of the Faculty of Psychology at Universitas Gadjah Mada (UGM), and the therapy module was formulated following the approval process. Participants, who voluntarily consented to take part in the study, were briefed on the treatment procedures during the initial session.

Pre- and post-test assessments were conducted to evaluate the effectiveness of the therapy. The acrophobia questionnaire was administered before the first session and immediately after the final session to assess changes in acrophobia symptoms. Additionally, the State-Trait Anxiety Inventory (STAI) and the Automatic Perception Questionnaire (APQ) were filled out by participants after exposure to the virtual height environment during each session from session three to eight.

In the first session, participants received a comprehensive briefing and overview regarding the nature of the treatment to be administered in subsequent sessions. Therapists also elicited pertinent information from participants concerning their experiences with acrophobia. During this session, participants were introduced to relaxation breathing techniques and cognitive restructuring methods. The session culminated with the assignment for participants to engage in relaxation exercises within their home environment, an integral facet of the therapeutic process that would unfold throughout the study.

The second session focused on discussing common reactions experienced by participants when confronted with height-related stimuli. Additionally, a detailed exposition of exposure therapy and cognitive restructuring was provided. Participants were introduced to the State-Trait Anxiety Inventory (STAI) and the Automatic Perception Questionnaire (APQ) in this session and assigned specific tasks as part of their involvement in the therapeutic process.

In the third through eighth sessions, participants underwent the Virtual Reality Exposure Therapy with Cognitive Restructuring (VRET-CR) treatment. They stood on a podium equipped with handrails for support and were fitted with biofeedback measuring devices connected to BioGraph. These devices monitored heart rate, respiratory rate, and skin conductance for approximately 20 seconds across eight different high-altitude situations. Participants were then immersed in height-related virtual environments using a VR camera and headset, allowing them to perceive themselves in an elevator ascending to a higher floor of a building and observe their surroundings in this elevated environment.

After each session from the third to the eighth, participants completed the State-Trait Anxiety Inventory (STAI) and the Automatic Perception Questionnaire (APQ) scales to assess their responses to exposure therapy. Alongside these assessments, participants engaged in reinforcement of relaxation and cognitive restructuring techniques, further solidifying their coping mechanisms. In the eighth session, a comprehensive review of the treatment process was conducted, providing an opportunity for participants to reflect on their progress and provide valuable feedback. This session served as a pivotal moment for both therapists and participants to evaluate the effectiveness of the interventions implemented thus far and to prepare for the final session, focusing on termination and relapse prevention strategies

The therapist held a termination session in session nine. To assess changes in acrophobia levels, participants completed the Acrophobia Questionnaire (AQ), followed by discussions on relapse prevention strategies, marking the conclusion of the therapy process. Participants were rewarded with a cash incentive of IDR 25,000.00, and upon completion of the ninth session, each participant received a booklet

1.5 Data Analysis

The data analysis involved comparing the gain scores for anxiety between the experimental group and the control group using the Independent Samples t-test. Specifically, the analysis compared the Acrophobia Questionnaire (AQ) scores before and after the intervention (AQ1 and AQ2) for both groups. The software used for analyzing the scale data was IBM SPSS Statistics version 23.

2. Results

To assess the effectiveness of the VRET-CR therapy module in reducing acrophobia symptoms, an independent sample t-test was conducted to analyze the data regarding changes in AQ anxiety and avoidance scores between the two groups. This statistical test allows for a comparison of means between the experimental group (those who received the VRET-CR therapy) and the control group (those who did not). See Table 1 The data analysis results

Table 1
Independent Sampel t-test Gain AQ

Variable	Group	N	Mean	t
Gain AQ 1	Eksperiment	13	-37,77	-6,173*
	Control	14	-1,07	
Gain AQ 2	Eksperiment	13	-7,38	-4,250*
	Control	14	0,71	

Note. AQ1 = AQ-Axiety; AQ2= AQ-Avoidance

presented in Table 1 indicate that there are significant differences in the mean gain scores for AQ 1 [t(17.08) = -6.173; $p < 0.05$] and AQ 2 [t(25) = -4.250; $p < 0.05$] between the two groups. See Table 2 The paired-sample

Table 2
Paired Sample t-test Experimental Group

Pair	Mean	Std. Deviation	t	Sig. (2-tailed)
AQ 1 Pretest-Posttest	37,769	19,413	7,015	0,000
AQ 2 Pretest-Posttest	7,385	5,237	5,084	0,000

t-test analysis (Table 2) conducted on the experimental group also yielded significant results, implying that the therapy intervention had a notable impact on acrophobia symptoms within the experimental group, and these changes remained evident even three weeks after the conclusion of the experiment (Table 3)

Table 3
Pair Comparisons Skor AQ

Time	Time	AQ 1	AQ 2
		Mean differences	Mean differences
1	2	37.769*	7,385*
	3	34.077*	7,385*
2	1	-37.769*	-7,385*
	3	-3.692	0,000

Note. Time 1= Pretest, 2=posttest, 3=follow-up

2.1 Psychological Indicators

In order to examine changes from session to session, beginning with the participants' initial exposure to virtual reality and continuing until the conclusion of the exposure, repeated assessments of the STAI and APQ scales, as well as physiological reactions, were deemed necessary. Due to non-compliance with the assumption of sphericity in the STAI and APQ scores across the six sessions, differences in scores were evaluated using the Greenhouse-Geisser correction, as depicted in Table 4, which indicates significant results for STAI [F(2,292)= 17.976, $p < 0.05$] and APQ [F(1,520)= 11.446, $p < 0.05$]. Furthermore, as

Table 4
Within Subjects Effect STAI dan APQ

Variable	Acuan Asumsi	df	F	Sig.
STAI	Greenhouse-Geisser	2,292	17.976	.000
APQ	Greenhouse-Geisser	1,520	11.446	.001

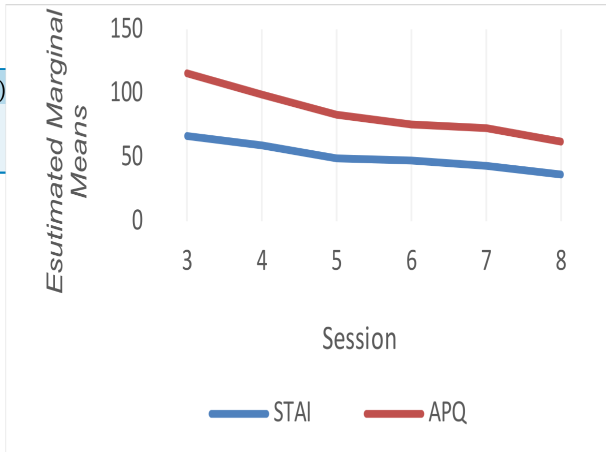
observed from Table 4, it is evident that the VRET-CR intervention, supported by therapeutic contributions, had a substantial influence, accounting for 87.2% of the variance in STAI scores and 83.1% of the variance in APQ scores. 5 The trends in both scales across sessions can

Table 5
Tes Multivariate STAI dan APQ

Variable	F	p	Partial Eta Squared
STAI	10.921	.002	.872
APQ	7.880	.006	.831

also be visualized in Figure 5

Figure 5
Profile Plot STAI dan APQ



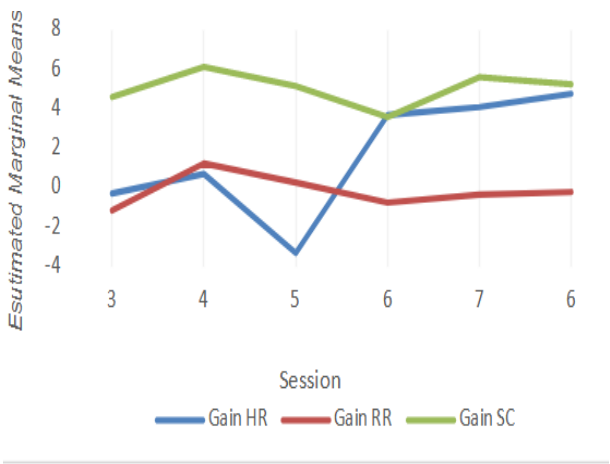
2.2 Physiological Indicators

The measurement of physiological responses was conducted by examining the score differences between after exposure to height situations and before exposure from sessions 3 to 8 across three indicators: heart rate (HR), respiratory rate (RR), and skin conductance (SC). Prior to analyzing the repeated measures of the three indicators, a Test of Sphericity was performed to assess variance homogeneity. According to Table 6, it is noted that only Gain HR [F(5)=4.467*; p<0.05] and Gain RR [F(5)=0.630; p>0.05] meet the assumption of variance homogeneity. As Gain SC does not conform to this assumption, the Greenhouse-Geisser value is examined [F(1,321)=0.684; p>0.05] It is evident that the six sessions of VRET-CR produced a significant change in Gain HR but not in Gain RR and Gain SC. Interestingly, there was an increase in gain scores for all three indicators in the last three exposures for Gain HR and the last two exposures for Gain RR and SC, as observed visually in Figure 6.

Table 6
Within Subjects Effect Respons Fisiologis

Variable	Acuan Asumsi	df	F	p
Gain HR	Sphericity Assumed	5	4,467	0,002
Gain RR	Sphericity Assumed	5	0,630	0,678
Gain SC	Greenhouse-Geisser	1,321	0,684	0,460

Figure 6
Profile Plot Gain HR, RR,SC



The decrease in gain scores for all three indicators occurred during session 5 for Gain HR and session 6 for both Gain RR and Gain SC.

2.3 Discussion

The aim of this study is to validate the content and empirical aspects of the Virtual Reality Exposure Therapy-Cognitive Restructuring (VRET-CR) module for reducing acrophobia symptoms. Content validation was conducted through a judgment process involving five experts who provided ratings from 1 to 5 for four components: activity relevance, overall assessment, language, and presentation. In terms of content validity, the module employed in this research has been demonstrated as valid, as indicated by Aiken's V values exceeding 0.5 for each module component, with an average Aiken's V of 0.89 (V > 0.5).

Empirically, the VRET-CR module has been validated as effective in reducing acrophobia symptoms, as evidenced by a significant decrease in AQ-anxiety and AQ-avoidance scores before and after the therapy sessions. These findings are consistent with research conducted by Donker et al. (2019), which also utilized virtual reality (VR) technology combined with cognitive-behavioral therapy (CBT) techniques, demonstrating the ability to reduce Acrophobia symptoms within a three-week period. However, it's worth noting that the therapy employed by Donker et al. (2019) was conducted independently and remotely by clients using self-guided methods.

Significant changes in AQ scores were also found in the study conducted by Choi et al. (2001). In that research, a single participant received six therapy sessions, resulting in a reduction of acrophobia symptoms. The findings of this study further support other research applying VRET in conjunction with CBT techniques but for different psychological disorders, including aviophobia symptoms (Botella et al., 2015), panic disorder (Vincelli et al., 2003), and agoraphobia (Ramon et al., 2008).

In addition to the reduction in AQ scores, the decrease in acrophobia symptoms experienced by participants is also evident from the changes in psychological and physiological reactions observed repeatedly from session to session. Significant reductions were found in State-Trait Anxiety Inventory (STAI) and Autonomic Perception Questionnaire (APQ) scores. However, it is worth noting an interesting finding in the physiological reactions, where significant score reductions were observed only in the fifth session for the heart rate (HR) indicator, while for the respiratory rate (RR) and skin conductance (SC) indicators, significant reductions occurred in the fourth and fifth exposures.

When related to one of the underlying principles of the VRET process, the changes experienced by participants, particularly in psychological reactions, can be explained using the Emotional Processing Theory proposed by Foa and Kozak (1986). According to this theory, the reduction in anxiety occurs as a result of the habituation process, both during the session (within-session habituation) and between sessions (between-session habituation) (**Huppert2006**). In this study, the focus was primarily on between-session habituation as it has been demonstrated to be most closely related to symptom change and provides critical insights into habituation patterns (Sripada & Rauch, 2015).

However, before delving further into the discussion of habituation processes in this study, it is important to emphasize that the virtual high-altitude environment presented was also found to activate the fear structure, as postulated by (Lang (1977) as cited in **Woo2016empty citation**). This activation was manifested by high STAI and APQ scores during the first exposure, which were nearly equivalent to pretest scores, indicating that participants were vividly imagining themselves in high-altitude situations. The activation of this fear structure was followed by the stimulation of physiological reactions, as evidenced by the pronounced trends in all three physiological indicators during the first and second exposures. Observational results also indicated that nearly all participants displayed panic-like behaviors, trembling, and restlessness during the first and second exposures

In addition to the elicited psychological and physiological reactions, participants also reported a profound sense of meaning derived from the situations they encountered. They articulated that the virtual environment truly induced anxiety akin to real-life scenarios. This observation underscores the capacity of the virtual environment to enhance the feeling of 'presence,' a crucial aspect of VRET implementation (Alsina-Jurnet et al., 2011). Through the Cognitive Restructuring (CR) technique, participants were also encouraged to express their negative thoughts and provide alternative thoughts related to the presented high-altitude situations. This information proved pivotal in confirming whether participants had achieved corrective learning, which is a crucial milestone in accordance with the Emotional Processing Theory (Kapfhammer et al., 2016).

”The shift in meaning regarding high-altitude situations was corroborated by participant reports following each VR exposure session. Most participants no longer perceived high-altitude situations as fearful. These adaptive cognitive changes were also observed in research conducted by Choi et al. (2001) and Ramon et al. (2008), both of which employed CBT techniques as supportive elements alongside VRET.

As previously mentioned, there was an intriguing finding regarding the changes in physiological reactions. Following the decline in physiological indicator scores during the third and fourth exposures, there was an increase in scores in subsequent sessions. This phenomenon has also been observed in research conducted by Orman (2003). In that study, a discrepancy was found between psychological and physiological measurements in participants. During some exposure sessions, Orman (2003) noted that the elevated heart rate did not always align with the self-reported anxiety levels, particularly when participants were exposed to the virtual environment. However, this contrasts with the findings of Shiban et al. (2017), who reported a reduction in physiological indicators coinciding with a decrease in participant anxiety.

One of the factors that may contribute to the increase in physiological indicators is the emotional state experienced by participants. This is supported by reports from the majority of participants during the last two exposures. While they no longer experienced intense anxiety as in the first exposure, other positive affective responses emerged, such as feelings of joy, pride, and happiness, as they did not anticipate the changes that occurred.

Kirschner et al. (2019) reported in their research that positive emotional states like excitement had a significant effect on increasing heart rate during the intervention process. Furthermore, Kreibig (2010) demonstrated that emotional responses to positive experiences were associated with an increase in several variables indicative of sympathetic nervous system activation. Interestingly, these positive experiences were also influenced by positive feedback given to participants (Kreibig, 2010), similar to the affirmations and appreciation provided by therapists to participants in this study.

However, the involvement of emotions in this physiological response needs further consideration, as obtaining valid data on the relationship between the autonomic nervous system and emotions remains a challenge (Kreibig, 2010). Both positive and negative emotions can activate the sympathetic nervous system, leading to increased heart rate, for instance (Kreibig, 2010). Additionally, Shiota and Kalat (2012) emphasized the need for caution when investigating the spectrum of positive emotions. Unfortunately, this study did not delve further into the specific positive emotions experienced by each participant.

This study has several limitations that warrant emphasis. As previously discussed, the research exclusively gathered quantitative data on anxiety reduction using the STAI scale. In contrast, the identification of other emotions that participants may have experienced was only conducted through interviews conducted after each exposure session. This limitation highlights an area for improvement in future research, which could involve incorporating scales to capture the positive affect that may arise during the therapy process, allowing for a more comprehensive data triangulation.

Furthermore, this study did not investigate whether participants engaged in avoidance behaviors such as closing their eyes while using the head-mounted display. Regarding this matter, the therapists had assured each participant that their eyes remained open during the exposure sessions. Only one participant admitted briefly closing their eyes out of surprise, while the rest confirmed that they did not close their eyes during the exposure.

Another limitation was the challenge of maintaining consistency among some participants in completing relaxation exercises outside of the sessions. Some participants cited reasons such as time constraints due to academic activities or falling asleep when attempting relaxation exercises. However, others reported being accustomed to relaxation techniques and were unsure if they had completed the exercises or not. Nevertheless, all participants found relaxation techniques highly beneficial for reducing anxiety in various situations.

As a final consideration, this relates to a study conducted by Muhlberger et al. (2003), which found that the combination of VRET and CR resulted in lower anxiety compared to the other two conditions (CR alone and control/no treatment). However, these changes were only observed in the short term. This serves as a note for future research to conduct follow-up assessments approximately six months after the completion of this experiment with participants to determine the long-term effects of the therapy provided.

3. Conclusion

The results of this study demonstrate that the Virtual Reality Exposure Therapy-Cognitive Restructuring (VRET-CR) module is effective in reducing acrophobia symptoms, as evidenced by significant differences in gain scores and psychological and physiological responses between the experimental group and the control group. Future research should consider incorporating psychological scales, such as the Positive and Negative Affect Schedule (PANAS), to capture positive emotions after each session and explore the role of additional variables in therapy outcomes. To address the limited availability of virtual reality technology in some psychological service facilities in Indonesia, developing self-help-based therapy methods using smartphones and affordable head-mounted displays is recommended. Therapists can utilize acrophobia applications, available for free or purchase, with remote monitoring and follow-up. Additionally, integrating novel features like interactive elements, gamification, and immersive storytelling into VRET-CR could enhance engagement and therapeutic benefits.

4. Declaration

4.1 Acknowledgment

This research was undertaken as part of a master’s degree final project, completed in the year 2019. The authors extend their heartfelt gratitude to all participants, members of the Virtual Reality Research Group, colleagues from AMIKOM University Yogyakarta, and all other individuals who contributed to the success of this study. Special recognition is given to the late Mrs. Neila Ramdhani for her instrumental role in initiating, facilitating, and supporting the research team. Additionally, sincere appreciation is expressed to Mrs. Muhana Sofiati Utami for her unwavering guidance and mentorship throughout the research process.

4.2 Authors' Contribution

The research design, data collection, and data analysis were conducted collaboratively by MF and NR. MF, in conjunction with MSU, meticulously reviewed, refined, and approved the final manuscript.

4.3 Conflict of Interest

The authors affirm that there are no conflicts of interest associated with the research and publication of this article.

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