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Investigating the Relationship Between Personality and the Experience of Presence in VR

Bachelor's thesis in Psychology
Supervisor: Ingvild Saksvik-Lehouillier
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Abstract

Previous research has indicated ambiguous associations between personality traits and users' experience of presence within immersive virtual environments. Variations in operationalization and measurement approaches for both personality and presence have further complicated cross-study comparisons. The current study aimed to further investigate this relationship by examining the Big Five personality traits across two immersive virtual reality scenarios. The study is based on the following research question: How do the Big Five personality traits influence individuals' experience of presence in immersive virtual reality scenarios? In total, 47 participants were recruited, who completed two questionnaires assessing personality, fear, emotion regulation and presence. Additionally, they participated in a VR experiment consisting of two conditions, one neutral and one negative. The findings of the study revealed significant relationships between the sense of presence and the personality traits of neuroticism and extraversion, whereas neuroticism was negatively correlated, and extraversion was positively correlated. A regression analysis identified that the combined effect of neuroticism and extraversion predict presence, although neither trait were found to be a predictor individually. These results underscore the importance of considering personality as essential variables in shaping the experience of presence in VR. Furthermore, deviations from previous findings highlight the need for further exploration into the application of VR in the field psychology.

Sammendrag

Tidligere forskning har vist tvetydige sammenhenger mellom personlighetstrekk og brukeres opplevelse av tilstedeværelse i oppslukende virtuelle miljøer. Variasjoner i operasjonalisering og målemetoder av både personlighet og tilstedeværelse har ytterligere komplisert sammenligninger på tvers av studier. Målet med denne studien var å undersøke dette forholdet nærmere, ved å bruke personlighetstrekkene i Femfaktormodellen i to oppslukende virtuelle scenarioer. Studien tar utgangspunkt i følgende forskningsspørsmål: Hvordan påvirker personlighetstrekkene i Femfaktormodellen individers opplevelse av tilstedeværelse i oppslukende virtuelle scenarioer? Totalt ble 47 deltakere rekruttert, som fullførte to spørreskjemaer som målte personlighet, frykt, emosjonsregulering og tilstedeværelse. I tillegg deltok de i et VR-eksperiment bestående av to betingelser, én nøytral og én negativ. Funnene i studien avslørte signifikante sammenhenger mellom følelsen av tilstedeværelse og personlighetstrekkene nevrotisisme og ekstroversjon, der nevrotisisme var negativt korrelert og ekstroversjon var positivt korrelert. En regresjonsanalyse identifiserte at den kombinerte effekten av nevrotisisme og ekstroversjon predikerer tilstedeværelse, selv om ingen av dem ble vurdert som individuell prediktor. Disse resultatene understreker viktigheten av å vurdere personlighet som essensielle variabler for å forme opplevelsen av tilstedeværelse i VR. Videre, fremhever avvik fra tidligere funn behovet for ytterligere utforskning av broken av VR innenfor psykologien.

Investigating the relationship between personality and the experience of presence in VR

Virtual Reality (VR) is a three-dimensional environment generated by a computer, that enables the individual to perceive experiences as if they were real (Abbas et al., 2023; Markowitz et al., 2018). Along the rapid technological development, the usage of VR has increased, with a growing tendency of utilization across various domains, including education, medicine and psychology (Hamad & Jia, 2022). As the virtual environment has become more reality-like and realistic, there are two critical dimensions that needs to be fulfilled for an authentic user experience: presence and immersion (Markowitz et al., 2018). These two dimensions can be influenced by various components, involving both technology and individual differences (Alsina-Jurnet & Gutiérrez-Maldonado, 2010). This leads to the understanding that the same virtual environment, can be perceived differently based on the user's personality (Ling et al., 2013).

As VR's application extends from entertainment to educational, therapeutic, and medical domains, understanding how individual differences and personality traits influence presence becomes crucial (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Ling et al., 2013). This is particularly evident in the use of VR within the ambit of psychological therapy, for instance exposure therapy, where consideration of individual variances in the sensation of presence is of great importance. The requirement for such research is vital not only for enhancing VR's realism and usability, but also, among other thing, for tailoring therapeutic internecions in psychology to enhance the intervention. With ongoing advancements in VR technology, deeper insight into immersion and presence along with the influence of personality is needed, as it becomes conceivable to envision VR as a resource effective psychological tool in the future.

Definitions

Virtual Reality is a reality-like environment, generated by computers, with the aim of immersing the user into the simulated world, blurring the distinction between the virtual and the physical (Abbas et al., 2023; Hudson et al., 2019; Markowitz et al., 2018). Virtual reality can either be immersive or non-immersive, depending on the equipment. Immersive VR uses a head-mounted display with a 360° angle and a three-dimensional effect, while non-immersive VR is played on a regular display (Omlor et al., 2022).

Immersion involves the making of an illusion that stimuli within the virtual environment replace stimuli from the real world, aiming for users to completely forget they are in a virtual world (Hudson et al., 2019; Markowitz et al., 2018; Tcha-Tokey, Christmann, et al., 2016). Immersion revolves around the objective properties in VR, regarding the technological issues such as the quality of the display, surrounding sound and graphics (Thorp et al., 2023). Immersion is often closely associated with presence, and literature suggests that a heightened sense of immersion can lead to a stronger sense of presence (Dalgarno & Lee, 2010; Weibel & Wissmath, 2011).

Presence can be described as the feeling of actually being there (Murphy & Skarbez, 2020), and is often valued as an essential aspect of usability and user experience in virtual environments (Tcha-Tokey, Loup-Escande, et al., 2016). The sense of presence is a subjective experience, which means even though participants are immersed in the same VR conditions, they can perceive presence differently because of personality and individual differences (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Kober & Neuper, 2013; Ling et al., 2013; Murphy & Skarbez, 2020). Measuring presence is therefore fundamental for both VR research and its further development, particularly within the field of psychology (Schwind et al., 2019).

Personality is often defined as relatively stable internal characteristics of an individual, and are reflected in their behavior, attitudes and emotions (Thorp et al., 2023). Personality is considered to be more or less stabile throughout a person's life, but also dynamic in a way that changes in line with experiences and life situations (McCrae et al., 1997). Personality has been a psychological field of interest in several years, with different ways and methods to investigate and measure it. In the last decades, the Five Factor Model, commonly known as Big Five, has become the dominant model to use (McCrae, 2009), which is based on measuring five distinctive personality traits: neuroticism, extraversion, openness, agreeableness and conscientiousness.

Virtual reality and psychology

Along with the rapid technological development, VR has achieved a substantial growth in the entertainment industry, but also in science, education and research (Schwind et al., 2019). In addition to the advancements in technology, the fast growth in interest towards VR can be related to the increase in availability, affordability, and ease of use (Hamad & Jia, 2022; Rangelova et al., 2020; Renganayagalu et al., 2021). One of the greatest features of VR in psychological research, is the ability to create customizable environments for various purposes, and to provide access to environments that may be difficult to attain otherwise, without concerns related to danger and high costs (Bell et al., 2020; Rangelova et al., 2020). Research exploring the outcomes of VR-based therapy, has found that VR-based exposure therapy (VRE) may achieve efficacy levels comparable to traditional, in-vivo exposure therapy, especially in the treatment of social phobia (Wechsler et al., 2019). Additionally, the utilization of VR within research secures ecological validity, compared to ordinary laboratory studies (Kisker et al., 2021; Parsons, 2015). This makes a great fundament for further development and research on the usage of VR technology in the psychological field.

Presence in virtual reality

Presence and immersion are considered as two of the most important factors in evaluating the quality of VR experiences (Jung & Lindeman, 2021). Furthermore, they are assumed to mutually influence each other (Ling et al., 2013; Newman et al., 2022). Most researchers seem to agree that the sense of presence in VR are influenced by both technology- and user related factors (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Kober & Neuper, 2013). The more realistic and life-like the environment is experienced, the more immersed the user gets, and a higher sense of presence tends to be reported (Ling et al., 2013; Newman et al., 2022). An improved sense of presence within virtual scenarios not only bolsters the realism of the experience, but is also found to support precise and ecologically valid usability assessments (North & North, 2016). Furthermore, empirical evidence suggests that a heightened presence positively influences the outcomes of VR interventions. It promotes performance and relates with both usability and the users' general experience of the VR system (Brade et al., 2017; Voinescu et al., 2020).

While previous research has primarily concentrated on the objective immersive factors influencing presence, this study aims to investigate the role of personality and individual differences as these factors potentially can have a great influence on the overall presence experience. With the increasing prevalence of VR across various domains, it becomes crucial to pay attention to human factors and acknowledge its significant role (Kober & Neuper, 2013). Focusing on gathering insight to increase the sense of presence, while acknowledging individual differences, is essential, as it allows for tailored facilitation of VR scenarios and improves both the quality of the virtual experience and the sense of presence.

The influence of personality on presence

The existing body of research regarding the relationship between personality traits and the experience of presence in VR, presents a complex and occasionally contradictory landscape. Bouchard et al. (2008) and Alsina-Jurnet and Gutiérrez-Maldonado (2010) were among early studies to find that high levels of anxiety, related to the personality trait of neuroticism, were associated with heightened feeling of presence in virtual environments. In further research on the influence of neuroticism, noted Weibel et al. (2011) an enhanced sense of presence in different types of films among individuals with higher scores on neuroticism. These findings were supported in later research by Grassini et al. (2021), who posited that both anxiety and neuroticism could significantly impact users' virtual experiences and increase the sense of presence.

Conversely, the relationship between extraversion and presence has yielded mixed results. An early study from 2004 identified that extroverted people had higher scores on presence, compared to introverted individuals (Laarni et al., 2004). In contrast, found Alsina-Jurnet and Gutiérrez-Maldonado (2010) a negative correlation between extraversion and the feeling of "being there", implying that more introverted individuals experience higher sense of presence.

Sacau et al. (2008) reported a positive association between presence and individuals high on openness to experience when investigating the relationship. This correlation was further substantiated by the findings of both Kober and Neuper (2013) and McLeod et al. (2014). However, challenging the consensus on the impact of personality traits on presence, Thorp et al. (2023) reported a lack of significant correlations between any of the Big Five traits and the sense of presence within VR scenarios. This result is somewhat aligned with Sacau et al. (2008), who concluded that the Big Five personality traits contribute minimally to the presence experience.

Measuring presence and personality

Along with the discovery of conflicting results when comparing existing studies, there is also a remarkable variation in the methodologies employed, particularly in the measurement of presence. The absence of a standardized measurement poses a noteworthy challenge when comparing outcomes across different studies. As presence is a subjective sense, it is commonly assessed through self-report questionnaires. Previous research examining the relationship between personality and sense of presence has applied several different presence questionnaires, for example the I-Group Presence Questionnaire (IPQ), the Presence Questionnaire (PQ), the Short Feedback Questionnaire (SFQ) and the Slater-Usoh-Steed Presence Questionnaire (SUS) (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Kisker et al., 2020; Kober & Neuper, 2013; Ling et al., 2013; Thorp et al., 2023), which all are validated and applied after the VR experiment.

The challenge in inconsistency of presence measurement is exemplified in a study conducted by Kober and Neuper (2013). They investigated the relationship between presence and personality using three different measurement scales: SFQ, SUS and PQ. The SFQ contains six items related to presence measured on a 5-point likert scale, while the SUS contains five presence related items, measured on a likert scale from 1 to 7. The PQ contains of 19 items related to three different subscales, all assessing diverse aspects of presence, and the participant rates the experience on a likert scale from 1 to 7. Their findings revealed a statistically significant positive correlation solely when employing the SFQ scale, and no significant correlations with either the SUS or PQ scales. This illustrates the importance of operationalization and highlights the potential variability in research outcomes attributed to the choice of measurement.

In comparison with measuring presence, there has also been inconsistency in assessing personality, both theoretically and methodologically. Some studies have used the Five Factor

Model (Kober & Neuper, 2013; Thorp et al., 2023) while others have utilized different measures, for instance Eysenck's personality traits (Alsina-Jurnet & Gutiérrez-Maldonado, 2010) and other individual characteristics (Ling et al., 2013). Thorp et al., 2023 used NEO-FFI to assess the personality traits, whereas Kober and Neuper (2013) applied several questionnaires, including NEO-FFI, The Barratt Impulsiveness Scale and The Immersive Tendencies Questionnaire (ITQ). Alsina-Jurnet and Gutiérrez-Maldonado (2010) assessed personality through Eysenck personality questionnaire short Revised Version, and Ling et al. (2013) measured personality by combining the ITQ, Davis' Interpersonal Reactivity and the Locus of Control questionnaire, among others. This theoretical and methodical inconsistency complicates the comparison of results across studies and creates ambiguity regarding the methods future research should utilize. In this current study, the traits of the Big Five Model will be used to assess personality, as it is well validated and the most common method to use in psychological research nowadays (McCrae, 2009).

The divergence in findings among research on personality traits and presence, highlights the complexity of how individual differences can affect perceptions of VR. Additionally, the contradictory findings caused by inconsistency in operationalization demonstrates the need for more standardized methods. To be able to take advantage of the possibilities of VR within the psychological field, further research is necessary, and more knowledge regarding personal adaption needs to be gained.

Question to be researched

The present study aims to investigate the relationship between the sense of presence in VR environments and personality further, as previous studies have conflicting results, and have indicated that more research is needed. The research question for this study is formulated as:

How do the Big Five personality traits influence individual's experience of presence in immersive virtual reality scenarios?

Hypothesis

The presented literature and research question led to the formulation of the following hypothesis:

H1: The sense of presence will be higher for participants with high score on neuroticism

H2: The sense of presence will be higher for participants with high score on extraversion

H3: The sense of presence will be higher for participants with high score on openness

H4: Agreeableness and conscientiousness will not influence the sense of presence

Methods

Sample

A total of 47 participants took part in the project, and the sample mainly consisted of students from the Norwegian University of Science and Technology (NTNU). The participants were recruited through convenience sampling, as this methos is both time- and cost effective. All participants received an information form prior to their attendance and gave their informed consent through a digital form. Participants with previous psychological or neurological disorders were excluded from the study, as well as individuals who had seen, considered seeing, or had been recommended to see a psychologist over the past 5 years. Inclusion criteria for participants' age were set to 18 to 35 years old. The sample of 47 consisted of 30 woman (64%), 15 men (32%), while two participants did not answer the gender question (4%). The age of the participants varied from 18 to 30 with a mean age of 22 (*SD*= 2.17).

Design and Procedure

The study employed a mixed-methods design, incorporating two surveys and one VR experiment, to investigate the research question. Participants were invited to the VR-laboratory at NTNU Dragvoll, where both the surveys and the experiment took place. The sampling period ranged from 4th of March to 20th of March, and the project was described to the participants as a psychological investigation into the relation between personality and VR.

In the experimental period, two rooms were used, to enable more than one participant at the same time. One room was equipped with two computers, and the other one was the VR-laboratory. At times when more than one participant was attending at the same time, they were separated to ensure individual participation. One participant completed the questionnaire, while the other performed the experiment. Furthermore, they were also

instructed to refrain from communication with each other to avoid shared information and bias.

Initially, participants began with a questionnaire assessing personality traits, emotional regulation and their state of fear using a combination of the International Personality Item Pool 120 version (IPIP120), the Emotion Regulation Questionnaire (ERQ) and the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ). Following this, the participants were introduced to the VR experiment, given a short description on the procedure and remined their right to withdraw at any time. All participants were informed that assistance during the experiment would be limited to technological queries. Additionally, they were all instructed to interact naturally within the virtual environment, avoiding unusual actions like walking through bushes or walls, and to keep within the virtual setup.

For the experimental setup, sensors were attached to the participants' hands and feet using Velcro straps over their clothing, to measure their movements. Consistency in sensor placement was maintained across all participants. To ensure uniform haptic sensations, all participants wore identical black slippers with a thin rubber sole, available in two sizes, as illustrated in figure 1.

Figure 1

Slipper's Participants Used During the Experiment

The experimental layout, detailed in figure 2, illustrates the starting position and the arrangement of the virtual environment. At the experiment's start, participants were positioned on the marked start point and equipped with the head mounted VR headset, alongside the sensors and slippers. They were all instructed to remain still for 3 to 5 seconds to allow the VR environment to stabilize before commencing movement. The task presented to the participants involved navigating through the virtual space to find a "level complete" sign, as shown in Figure 3. To reach the finish, participants had to follow a path, walk into an opening in the brick walls and explore both left and right sides in the corridor. The design required participants to enter specific areas located on both sides of the corridor, as illustrated by the striped boxes in figure 2, in order to trigger the appearance of the "level complete" sign on the opposite side. When the sign was found, the experiment was finished, and participants took off the equipment and returned to the other room to finish the surveys.

Figure 2

Layout of the Experiment
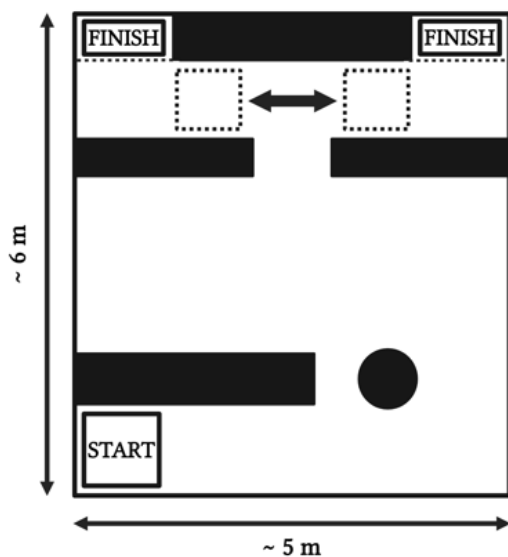
Figure 3

Level Complete Sign in the Virtual Environment

Upon completing the experiment, participants filled out the Immersive Virtual Environment Questionnaire (IVEQ), which assessed their subjective experience with immersion and presence in the VR environment. After finishing the last survey, a debriefing session was provided to all participants to ensure adherent to the ethical guidelines.

Virtual Reality Environment

The VR environments was created especially for this project, by two student assistants at NTNU, and consisted of a garden filled with trees and bushes, and a path that led into a small labyrinth. The experiment comprised two conditions: one neutral and one negative. All participants experienced both conditions, but in a randomized order. Figure 4 and 5 shows the layout of the neutral condition, and figure 6 and 7 shows the layout of the negative condition. Both conditions had the same virtual setup and task, but the neutral one was in daylight with bird chirping, while the negative one was supposed to be scarier with darkness, torches and creepy bird sounds. Prior to the experiment, participants were unaware that they were to undergo two separate conditions. Additionally, they were not informed that the setup and task would remain the same for both conditions, but with different ambiance.

Figure 4

Virtual Environment – Neutral Condition

Figure 5

Virtual Environment – Neutral Condition

Figure 6

Virtual Environment – Negative Condition

Figure 7

Virtual Environment – Negative Condition

Ethics

Prior to the commencement of the project, the study proposal and the processing of personal data were approved by The Norwegian Agency for Shared Services in Education and Research (Sikt), 24th of January 2024, with the following reference: 494059. All participants were informed about the purpose of the project and gave their consent to participate trough a digital form.

Measurements

In order to acquire necessary information, several measurements were conducted in the project. The surveys consisted of four questionnaires in total: IPIP120 assessing personality, RST-PQ assessing fear, ERQ assessing emotion regulation and IVEQ assessing presence and immersion. Additionally, multiple sensors were used during the experiment to measure the participants movements. For the purposes of the current study's research question, only data from the IPIP120 and the IVEQ were considered.

Personality

A Norwegian translation of the IPIP-120 (Pran, 2021) was used to measure the personality traits of the Big Five Model: Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. The translated version is derived from the original English version (Johnson, 2014), and measures the five traits using 120 items, 24 items for each traits. All items are measured on a likert scale of five options; strongly disagree, disagree, neutral, agree or strongly agree, e.g. "I worry about things" and "I make rash decision". In the current study, the IPIP120 is considered to have good internal consistency, α= .80, with the following alpha values for each trait: neuroticism, α= .87, extraversion, α= .83, openness, α= .77, agreeableness, α= .83, and conscientiousness, α= .91.

Presence

After the experiment, immersion and presence were measured by a Norwegian translation of the IVEQ (Lønne et al., 2023). The original questionnaire consists of several subscales to measure the participant's experience (Tcha-Tokey, Christmann, et al., 2016), but for this project, only the subscales measuring presence and immersion were included. The questionnaire consisted of 19 items, whereas 12 assessed presences, e.g. "My interactions with the virtual environment seemed natural", and 7 assessed immersion, e.g. "I felt stimulated by the virtual environment". All items were measured on a 10-point likert scale, from 1 – strongly disagree, to 10 – strongly agree. For the present study, sole attention was given to the presence items, which demonstrated good internal consistency with an alpha value of .85.

Apparatus

Virtual Reality System

The virtual environment was built in Unity version 2021.3.3f1, using The High Definition Render Pipeline (HDRP), which permits creation of cutting-edge, high-fidelity graphics on high-end platforms.

The VR-headset utilized was the head-mounted Vive pro 2, which remained connected to a computer through a cable for the duration of the experiment, as shown in figure 8.

Figure 8

VR-Headset with the Attached Cable

Sensors

To gather movement data from the participants, five distinct sensors were applied: one integrated in the VR-headset, and four HTC Vive Tracker 3.0 devices affixed to the participants' hands and feet, as shown in figure 9.

Figure 9

All Equipment Used During the Experiments

Statistical analysis

After the data collection period, answers from the survey and data from the experiments were plotted into the statistical analysis program, Statistical Package for the Social Science (IBM SPSS), version 29.0.2.0 (20), by the supervisors, and then shared with the whole research group for further analyzes. The significance level for the analyses was set to $p = .05$. For descriptive analyses mean, standard deviation and frequency of participants were paid attention to.

To investigate whether personality traits influence the user's sense of presence, a correlation analysis was conducted. The values of skewness and kurtosis indicated slight deviations from normality, yet these deviations were not excessive. Furthermore, the Shapiro Wilk test was not significant, implying the data were normally distributed – a finding also supported by the visual inspection of histograms and the Q-Q plots. Given the normal distribution of the data and the variables being defined as scale, Pearson's correlation was the

appropriate methos for the analyses (Field, 2013). The dependent variable was the sense of

presence, while the independent variables encompassed the five personality traits –

neuroticism, extraversion, openness, agreeableness and conscientiousness – along with

gender, which was included as a background variable.

To further explore the relationship between the significant variables identified in the

correlation analysis and the sense of presence, a multiple regression analysis was conducted.

The aim of performing a regression analysis was to investigate the strength and direction of

the relationships further, and whether certain personality traits could predict the sense of

presence. In order to run the regression analysis, several assumptions were tested. To check

the correlations between residuals, a Durbin Watson test was used, resulting a value of 1.5,

which means the residuals are not too correlated, as it is between 0 and 4 (Field, 2013).

Additionally illustrated the histogram that the residuals were normally distributed, and the

residual statistics revealed a mean of 0. The scatterplot showed no extreme outliers, supported

by all standardized residuals being below ±3.29 (Field, 2013). The p-p plot was somewhat

challenging to interpreter, with minor tendencies of an S-curve, but as the residuals followed

roughly along the line, it was concluded that they were approximately normally distributed,

meeting the assumption for homoscedasticity (Field, 2013).

Upon examining the relationship between variables, the scatterplot revealed no linear

relationship. The highest correlation observed was -.43, between neuroticism and

extraversion, indicating a moderate effect size (Cohen, 1988). Thus, none of the predictors

exhibited a very high correlation, as high correlations typically are considered to be greater

than .80 (Field, 2013). Additionally, the highest Variance Inflation Factor (VIF) value was

1.23, which is not considered a concern as it below the threshold of 10, indicating there is

unlikely to be any multicollinearity issues (Bowerman & O'Connell, 1990; Myers, 1990).

Results

Correlations

A bivariate two tailed Pearson's correlation was performed to investigate the relationship between different personality traits and sense of presence, along with the background variable of gender.

Table 1

Descriptive Statistics and Correlation Coefficient for Presence, Personality & Gender

Variable		n	M	SD	1	2	3	4	5	6	7
1.	Gender	45	1.33	.48	-						
2.	Presence	47	7.59	1.26	.27	-					
3.	Neuroticism	47	2.44	.48	-.23	-.33*	-				
4.	Extraversion	47	3.52	.42	-.02	.32*	.43**	-			
5.	Openness	47	3.32	.40	-.03	.02	-.28	.27	-		
6.	Agreeableness	47	3.98	.35	-.49***	-.07	-.13	.08	.15	-	
7.	Conscientiousness	47	3.67	.52	.09	-.10	-.29	.17	-.16	.22	-

Note. $* p < .05, ** p < .01, *** p < .001$

Table 1 shows that there as a significant moderate negative correlation, $r(47) = -.33, p = .025$, between neuroticism and sense of presence, and a significant positive moderate correlation, $r(47) = .32, p = .028$, between extraversion and sense of presence. There was not a significant correlation between sense of presence and the remaining three personality traits, openness, $r(47) = .02, p = .88$, agreeableness, $r(47) = -.07, p = .63$, and conscientiousness, $r(47) = -.10, p = .52$. There was not a significant correlation, $r(45) = .27, p = .075$ between gender and presence.

Regression

To examine the relationship between the sense of presence and the personality traits of neuroticism and extraversion further and evaluate how well the variables predict the sense of presence, a multiple regression analysis was conducted.

Table 2

Multiple Linear Regression Coefficients Predicting Presence

Variable	*B*	*SE B*	β	R^2
Model				.15*
Neuroticism	-0.61	0.41	-0.23	
Extraversion	0.66	0.46	0.22	

Note. N = 47

* *p* < .05

Table 2 shows that the combined model of neuroticism and extraversion significantly predicts variance in the experience of presence, $F(2, 44) = 3.75$ $p = .031$. The model explains 15% of the variance in sense of presence ($R^2 = .15$). Upon further investigation of the individual predictors, neither neuroticism, $t(44) = -1.49$, β = -0.23, $p = .143$ nor extraversion, $t(44) = 1.43$, β = 0.22, $p = .161$ were found to be significant predictors.

Discussion

The aim of the study was to investigate how the Big Five personality traits influence the individuals experience of presence within immersive VR scenarios. This was done to emphasize how individual differences affect VR experiences, broadening the attention of VR research beyond technological aspects. Former research has identified contradictory results, whereas some studies have found significant associations between certain traits and presence, while others have concluded that the experience of presence is little affected by personality.

In the examination of the relationship between gender, the five personality traits, and

sense of presence in the current study, two significant relations emerged. Neuroticism was found to be negatively associated, while extraversion was found to be positively associated. When analyzed collectively, within the same model, they were identified as predictors to the sense of presence, but not independently.

Understanding the relationship between personality traits and sense of presence

The first hypothesis posited a positive relationship between the sense of presence within VR and the personality trait of neuroticism. This hypothesis was not supported, as the results indicated that high scores on neuroticism are related to a reduced sense of presence in VR. Individuals high on neuroticism are typically characterized as anxious, unstable and having low self-esteem (McCrae & Costa, 1987; Watson & Clark, 1984). These characteristics logically imply that neurotic individuals may exhibit nervous- and self-conscious behaviors, leading them to resist full immersion and experience lower levels of presence in unfamiliar environments. Additionally, it is conceivable that the attendance of strangers during the experiment could negatively affect the participant, and lead to increased self-consciousness. Nevertheless, the finding of a negative association contrasts with the majority of previous research, which typically identified a positive relationship between anxiety-related personality features and the sense of presence (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Bouchard et al., 2008; Grassini et al., 2021; Weibel et al., 2011). The divergence between these former studies, and the present study may stem from differences in operational definitions, measurement methods and variations in samples or sample sizes. For instance, Alsina-Jurnet and Gutiérrez-Maldonado (2010) utilized a sample of 210 students, measuring presence with the IPQ, while Bouchard et al. (2008) employed a sample of 31 adults, assessing presence through the PQ. In contrast, the current study involved a sample consisting of 37 students, using the IVEQ to measure presence.

The second hypothesis, on the other hand, anticipated a positive association between extraversion and sense of presence, which was corroborated by a significant positive correlation in the analyses. Individuals high on extraversion are typically characterized by their outgoing nature and enthusiastic behavior (McCrae & John, 1992), possibly making them curious and likely to devote into the VR as they are considered at ease with engaging with unfamiliar social activities. The conclusion of this hypothesis aligns with findings from an early study on the field (Laarni et al., 2004), but deviates from findings from more recent research, where introversion was found to positively influence presence (Alsina-Jurnet & Gutiérrez-Maldonado, 2010), or not found to be associated at all (Thorp et al., 2023). This inconsistency is challenging to interpret, mainly due to the similarities in the samples, primarily consisting of students and young adults. However, it is important to consider differences in publication years, given the rapidly evolving nature of the technological field. This justifies comparisons with newer research rather than older studies. Among more recent studies, variations in experimental design and tasks performed within the virtual environments are evident. In the experiment conducted by Thorp et al. (2023), participants were tasked with assembling a model plane, which also focused on training in addition to presence. This task likely engaged different cognitive processes compared to the experiment in our research, where the task can be considered less demanding.

Conversely, the third hypothesis, which assumed a positive relationship between openness and sense of presence, was not supported, as no significant correlation emerged. The personality trait of openness relates to curiosity and imagination (McCrae & John, 1992), and could therefore be expected to have a great influence on the feeling of presence. Contrary to the predictions, the results may suggest that being open to new experiences and curious as an individual does not necessarily result in a heightened sense of presence in a virtual environment. The disconfirmation of this hypothesis diverges from the findings of several

previous studies, where openness was found to increase the experience of presence (Kober & Neuper, 2013; McLeod et al., 2014; Sacau et al., 2008). Thus, the deviation from existing research is somewhat surprising, especially considering the similarities across studies. For example, in a study conducted by Kober and Neuper (2013), similar to the current study, a sample of 30 young adults were tasked with exploring and navigating in virtual environments. However, while the present sample includes both males and females, Kober and Neuper (2013) utilized a sample comprising only females. On the other hand, the noteworthy difference in publication years should always be taken into consideration, especially when comparing research involving technology. The selected previous studies were conducted over a decade prior to the current study, indicating considerable development within in the field of VR, that may affect the outcomes.

Finally, the fourth hypothesis, which predicted no associations between the sense of presence and the traits of agreeableness and conscientiousness, found support in the analysis, with the absence of significant correlations. This outcome signify that these traits may not be as relevant to the immersive qualities of VR that contribute to the experience of presence. Individuals high on agreeableness are characterized as trusting, appreciative and kind, whereas individuals high on conscientiousness are characterized as efficient, reliable and responsible (McCrae & John, 1992). Previous research has often focused on the influence of personality traits other than agreeableness and conscientiousness on the sense of presence, finding them to have greater importance (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Kober & Neuper, 2013; Sacau et al., 2008). This observation aligns with both the hypothesis and the findings of our research and can be attributed to the understanding that these traits primarily relate to interpersonal relationships.

The impact of neuroticism and extraversion on the sense of presence

      In this present study, individuals high on extraversion were found to have an enhanced sense of presence, whereas those with high neuroticism experienced a diminished sense of presence within the virtual environment. In further investigation into the relationship between the sense of presence and these two personality traits, they emerged as predictors when considered together, indicating that at least one of the independent variables directly impacts the sense of presence in VR. However, it's important to note that the combined effect of neuroticism and extraversion only explains about 15% of why people feel present in virtual environments. This proportion is considered relatively small (Field, 2013), implying that other factors also are at play. For instance, it is conceivable that the users' prior experience with VR could impact their sense of presence, or that individual differences in perception and attention contribute to the overall experience. Therefore, while personality traits are found to play a substantial role, they are not considered the sole determinants of presence in immersive virtual environments, and other factors might have greater influence.

      Although, neuroticism and extraversion together were found to be predictors of the sense of presence, neither stood out as significant predictors when considered individually. This result indicates that the combined effect of the two personality traits on presence provides more than their individual effects, illustrating a complex interplay between the two personality traits and presence, which can be caused by several issues. Firstly, it is possible that each trait has a small effect on its own but could not be detected due to the sample size. With smaller sample size and fewer observations, it is harder to detect significant effects for individual predictors, because of reduced statistical power (Field, 2013). Secondly, the identified moderate significant correlation ($r = .43$) between neuroticism and extraversion, might imply the possibility of underlying issues related to multicollinearity or interaction effects that may not be fully captured in the model. Such interactions, if present, could

obscure the unique contributions of each personality trait. In cases of multicollinearity, it is common for the combined effect of predictor variables to be found statistically significant, though, interpreting the individual effects of each predictor becomes more challenging due to the similarity in variance in the outcome. Because of this, it gets difficult to assess the unique contribution of each predictor and to disclose which variable is important (Field, 2013). However, given the moderate correlation of .43 and VIF value of 1.23, it is considered highly unlikely that multicollinearity is a notable concern in this analysis. Alternatively, there may be a suppression effect between the two traits, where one trait sabotage for the other. To investigate this further, it could be interesting for future research to perform a hierarchical regression. By systematically adding variables in steps, the analysis can reveal whether the effect of one trait is conditional on the level of the other trait, or if the order of entry into the model alters the predictive power of the variables.

Even though neither neuroticism nor extraversion was found to be a significant predictor individually, it is important to also consider their combined effect. This highlights the complexity of psychological responses in virtual environments and underscores the need for further research to unravel the dynamics of how personality traits influence the experience if presence in immersive VR.

Advantages and limitations

This study offers several advantages. Firstly, the application of a mixed method design proved advantageous in this study. By incorporating both survey and experimental methods, several benefits emerged. The VR experiment offered depth and information from an objective standpoint, as well as providing ecological validity, while the surveys secured breadth and insight from the participants perspective. The combination of this information is certainly valuable, enhancing the overall understanding of the phenomena and providing a

nuanced overview(Almalki, 2016; Kisker et al., 2021). Additionally, the use of self-report to

assess participants' personality and VR experiences is notably advantageous as it is both time-

efficient and cost-effective. Self-reporting enables valuable insight about participants'

experiences that might remain undisclosed through other methods. This approach alleviates

the participants concerns about bias like judgement, potentially providing more accurate

responses. On the other hand, is self-reportion criticized for its possibilities of bias such as

social-desirability bias and exaggeration (Althubaiti, 2016). Thus, the questionnaires included

in this study are well validated (Corr & Cooper, 2016; Gross & John, 2003; Johnson, 2014;

Tcha-Tokey, Christmann, et al., 2016) and does not concern sensitive nor directional themes.

The application of the Big Five Model is also advantageous, as it ensures a structured and

systematic framework for reviewing personality and individual differences. Additionally, it is

considered as a stable and dominant approach in personality psychology over the past decades

(McCrae, 2009).

The current study has also faced several limitations, due to different reasons. Initially,

the project period was postponed several times because of delays in delivery of equipment,

imposing time constraints. Consequently, the data collection period had to be shortened, and

the experiments had to be more efficiently conducted, including overlap between participants

in the VR lab. Despite these challenges, the sample still met the initial goal of 35 participants.

Secondly, the recruitment process might have impacted the study`s outcome. The method

used for sampling was convenience sampling, which is generally viewed as a limitation in

research because convenience samples have less generalizability (Jager et al., 2017). The

sample was primarily composed of university students, limiting its representativeness outside

of this specific demographic. Additionally, the predominance of students in the sample could

lead to limited variance in personality trait scores. Research suggest that university students

might exhibit similar levels of certain personality traits, such as conscientiousness and

openness to experience (Corazzini et al., 2021). Another limitation of the sample to be considered, is the strict inclusion criteria. Participants who had attended, considered attending or had been advised to attend a psychologist within the past five years was excluded from the study. These criteria might have been overly restrictive, minimizing variability in personality traits, especially neuroticism, potentially leading to the exclusion of individuals with high levels of neuroticism. Thus, as personality is one of the primary variables investigated in this project, this may have established a limited sample. Lastly, in the original study the plan was to use a wireless VR-headset to secure full immersion, but due to delays in delivery, an older headset was used which had to be connected to the computer by a cable. The cable was barely long enough to allow the participant to explore the entire VR environment, making it particularly challenging to reach features located furthest away, such as the areas for making the "level complete" sign appear. Moreover, during the experiment, the participant's movements caused the cable to twist, resulting in further shortening its effective range. Several participants were clearly aware of the cable and adjusted their movements accordingly during the experiment, for example turning in the right direction to avoid entanglement or holding the cable to prevent tripping. This might be considered as a limitation, especially since the study aims to investigate the sense of presence in immersive VR. Being overly conscious of the cable could significantly affect the users experience of presence and immersion.

Implications and further research

As the field of studying VR experiences within psychology is relatively new, investigating the influence of personality on these experiences remains highly relevant, especially with the increasing utilization of VR in therapeutic contexts. The findings of the current study reveal interesting directions compared to existing literature, underscoring the

need for further exploration. The results from the regression analysis demonstrates the necessity for more extensive investigations to identify which individual characteristics significantly impact the sense of presence, for instance applying hierarchical regression analysis. Future research should also consider incorporating additional variables and potentially exploring different modeling techniques, such as interaction effects or non-linear relationships. This approach will be able to provide a more comprehensive understanding of the factors influencing the sense of presence and how personality contributes to the experience.

The existing literature presents a spectrum of findings, whereas some studies aligns with the results from the present study (Laarni et al., 2004; Sacau et al., 2008; Thorp et al., 2023), while others deviate from them (Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Bouchard et al., 2008; Kober & Neuper, 2013). This divergence highlights the necessity for additional empirical investigations to address these inconsistencies. Prior research within this domain has lacked uniformity in both the measurement of personality and the assessment of presence, leading to variable and occasionally incompatible results. Future research should aim to establish and maintain standardized methodologies to facilitate more meaningful comparisons across studies. Additionally, is rigorous evaluation of different measures of presence crucial to determine the most effective one, thereby enhancing the credibility, reliability and validity of research outcomes.

To ensure representativeness and generalizability, subsequent studies should include larger and more diverse samples. Moreover, in investigating the sense of presence, the use of wireless headset is recommended, particularly when the VR task requires active exploration of the environment. This recommendation aligns with ongoing technological advancements, which not only expand research possibilities but also potentially enrich user experiences. In summary, given the relatively new field of VR within psychology, there is a pressing need for

concerted efforts to refine experimental approached and expand the empirical base in this emerging field of research.

Conclusion

  Over the past few decades, virtual reality technology has rapidly expanded beyond entertainment, finding applications in research, learning and psychology. The establishment of VR within the psychological field has shown interesting outcomes, particularly in exposure therapy, where its efficiency is comparable with classic in-vivio therapy. Existing literature has explored how the sense of presence impacts user experiences in virtual environments, identifying personality traits to play a crucial role in shaping this perception of realism. The present study aimed to investigate the relationship between the Big Five personality traits and the sense of presence in immersive VR, seeking insight that could enhance our knowledge on this field. Contrary to some prior research, the findings revealed that high neuroticism scores tend to lower the experience of presence, while high extraversion tends to heighten it. Interestingly, when combined, neuroticism and extraversion was found to predict the sense of presence, but not when considered as individual factors.

  The discoveries of the current study offer valuable insight and increase in the evidential support towards the conception of extraversion and neuroticism being the most influencing traits on the sense of presence. These findings, combined with prior research, enhance our understanding of the interplay of personality and sense of presence within immersive VR, thereby elevating the development of application of VR in therapeutic modalities. Moving forward, further investigations should focus on refining experimental methodologies and standardize measurement protocols to ensure the reliability and validity of future results. By doing so, we can gain deeper insight into the effective utilization of VR in psychology and the determinants of its impact.

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Appendix

Deklarasjon om KI-hjelpemidler

Emne og type dokument: ‥‥PSY2900 bacheloroppgave‥‥‥‥‥

Har det i utarbeidinga av denne teksten blitt anvendt KI-baserte hjelpemidler?

- ☑ Ja
- ☐ Nei

Hvis *ja*: Spesifiser type av verktøy og bruksområde under.

Tekst

- ☑ Stavekontroll. Er deler av teksten kontrollert av: *Grammarly, Ginger, Grammarbot, LanguageTool, ProWriting Aid, Sapling, Trinkia.ai* eller liknende verktøy?
- ☐ Tekstgenerering. Er deler av teksten generert av: *ChatGPT, GrammarlyGO, Copy.AI, WordAi, WriteSonic, Jasper, Simplified, Rytr* eller liknende verktøy?
- ☐ Skriveassistanse: Er en eller flere av ideene eller framgangsmåtene i oppgaven foreslått av: *ChatGPT, Google Bard, Bing chat, YouChat, My AI* eller liknende verktøy?

Hvis *ja* til anvendelse av tekstverktøy – spesifiser bruken her:

Words innebygde stave- og grammatikkontroll er brukt til språkvask av teksten

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Kode og algoritmer

- ☐ Programmeringsassistanse. Er deler av koden/algoritmene som i) framtrer direkte i teksten eller ii) har blitt anvendt for produksjon av resultater slik som figurer, tabeller eller tallverdier blitt generert av: *GitHub Copilot, CodeGPT, Google Codey/Studio Bot, Replit Ghostwriter, Amazon CodeWhisperer, GPT Engineer, ChatGPT, Google Bard* eller liknende verktøy?

Hvis *ja* til anvendelse av programmeringsverktøy – spesifiser bruken her:

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Bilder og figurer

-   ☐ Bildegenerering. Er ett eller flere av bildene/figurene i teksten blitt generert av: *Midjourney, Jasper, WriteSonic, Stability AI, Dall-E* eller liknende verktøy?

Hvis *ja* til anvendelse av bildeverktøy – spesifiser bruken her:

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-   ☐ Andre KI-verktøy: Har andre typer verktøy blitt anvendt? Hvis *ja*, spesifiser bruken her:

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☑ Jeg er kjent med NTNUs regelverk: *Det er ikke lov å bruke tekst eller innhold som noen andre har laget og late som man har skrevet eller laget det selv. Dette inkluderer tekst eller innhold laget ved bruk av kunstig intelligens.* Jeg har derfor redegjort for all anvendelse av kunstig intelligens enten i) direkte i teksten eller ii) i dette skjemaet.

Mia O. Dahl
⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯ 14.05.2024, ⎯Trondheim⎯⎯
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