Bachelor's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Psychology

Solveig Marie Sætre

An Assessment of Movement and Personality; Neuroticism and Extraversion as Predictors for Movement in a Virtual Reality Environment

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Supervisor: Håvard Rudi Karlsen
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Abstrakt

Flere eksisterende studier har forsket på personlighet og bevegelse hver for seg, men få studier har undersøkt deres samspill eller utforsket hvordan personlighet kan uttrykkes gjennom bevegelse. Målet med denne studien var å undersøke dette komplekse forholdet i et virtuelt virkelighetsmiljø (VR). I nyere tid har VR blitt et verdifullt metodisk verktøy i psykologi, som tilbyr innovative tilnærminger til forskning. Denne studien er blant de første som utforsker forholdet mellom bevegelse og personlighet ved hjelp av VR som forskningsverktøy. Deltakernes bevegelser ble sporet i et negativt og nøytralt VR-scenario, i tillegg til at et spørreskjema som vurderte ulike aspekter ved personlighet ble utfylt. Dette sørget for deltakerens skårer på ekstroversjon og nevrotisisme, samt data om gjennomsnittshastighet og bevegelsesmønstre, som representerte bevegelse og personlighet i denne studien.

Flere regresjonsanalyser ble utført for å undersøke om nevrotisisme og ekstroversjon påvirket deltakernes hastighet og generelle bevegelsesmønstre, samt en Sperman's rho-analyse som vurderte forholdet mellom variablene. Resultatene indikerte at de gjeldende personlighetstrekkene hadde liten til ingen prediktiv effekt på bevegelsesvariablene, selv om en svak signifikant sammenheng mellom gjennomsnittshastighet og nevrotisisme ble funnet. Innsikten fra denne studien understreker behovet for videre forsking innen dette feltet. Ettersom en svak sammenheng ble oppdaget i denne studien, burde videre forskning med bruk av større utvalgsstørrelser fortsette å undersøke om det er mulig å vurdere personlighet gjennom bevegelse.

Abstract

Numerous existing studies have researched personality and movement separately, yet few studies have examined their interaction, or further explored how personality can be expressed through movement. The present study aimed to investigate this intricate relationship within a virtual reality (VR) environment. VR has recently emerged as a valuable methodical tool in psychology, offering innovative approaches to research. The current study is among the first to explore the relationship between movement and personality using VR as a research tool. Participants movements were tracked in a negative and neutral VR-scenario, and a questionnaire assessing various aspects of personality was completed. This provided participants scores on neuroticism and extraversion, as well as data on average speed and movement patters, representing movement and personality in the present study.

To examine if neuroticism and extraversion influenced the participants speed and overall movement patterns, several regression analyses were conducted, alongside a Sperman's rho analysis to assess the relationship between the variables. Results indicated that these personality traits had little to no predictive effect on the movement variables, although a weak significant relationship between average speed and neuroticism was discovered. Insights provided by this study underscores the need for further research within this field. Since a weak association was discovered in this study, further research using larger sample sizes is essential to determine whether personality assessment through movement is feasible.

Introduction

With the increasing use of technology in the field of psychology, understanding human and computer interactions has never been more crucial. The evolvement of technological tools are reshaping research, therapy, education, and training presenting both new exciting possibilities and challenges (Wilson & Soranzo, 2015). As the technology rapidly evolves, the need to enhance knowledge about these interactions only becomes more important. The applications of immersive virtual reality have significantly expanded across many domains over the past two decades (Wilson & Soranzo, 2015). This evolution has paved the way for the integration of virtual reality (VR) into experimental psychology, where it can serve as a valuable tool to study emotional and cognitive processes in a realistic environment. VR's unique ability to replicate convincingly real environments with a high degree of control can potentially increase the ecological validity of psychological science (Schöne et al., 2023). To get a better understanding of the advantages and limitations of VR across various fields, it is essential to continue to study the mechanics and psychological dimensions of this type of technology. This can help developing the full potential of VR and identify possible limitations of VR as a research tool in psychology.

This study is specifically interested in investigating the relationship between movement and personality. The benefits provided by VR's capabilities in psychological research opens a new way to examine the relationship between these fundamental aspects of human behavior, and how they influence and interact with one another. Personality is one of the most complex constructs within the realm of psychology (Neuman, 2016). Despite extensive research on this topic, and numerous methods proposed for understanding and measuring personality, fully grasping the extent of factors influenced by personality on human behavior and experiences remains challenging. Investigating the relationship between movement and personality can provide critical insights into different aspects of human nature and valuable knowledge that can be applied to clinical, educational and practical settings (Delgado-Gómez et al., 2022).

Personality can be defined as a psychological construct aimed to explain human behavior in terms of a few, stable and measurable individual characteristics (Delgado-Gómez et al., 2022). One of the most recognized assessments for personality today is the Five-Factor Model (FFM), developed by Costa and McCrae, among others. Trait theory and self-reporting personality measurements are among the most common approaches to personality theory in psychology today. The FFM offers a respected and validated assessment of personality (McCrae & John, 1992), however personality is such a multifaceted construct that no single assessment is without its limitations. The universal abilities of FFM were challenged by Guvern et al. (2013) who failed to find robust support for the model in illiterate non-urban societies. This could indicate that the FFM model is better at explaining and measuring more modern and evolved aspects of personality. This could be a reflection of the fact that the model's origins stem from a lexical approach to describing personality (Kennair & Hagen, 2015). Movement has always been a part of human behavior, therefore using movement to assess personality could possibly provide insights to more banal aspects of our personality. Getting a better understanding of how personality manifests trough movement could not only complement existing assessment methods, but also broaden the knowledge about how personality is expressed, and furthermore personality and movement in general.

Theory

Virtual Reality

Virtual reality is an advanced computer-generated interface that simulates a realistic environment that can be interacted with in a seemingly real way using specialized equipment, such as head-mounted displays (HMDs) (Wu et al., 2020). The VR technology makes it possible for users to experience and interact with a 3D world that is not physically present, offering immersive experiences and engagement (Wu et al., 2020). The central objective of virtual reality is to give the participant a feeling of presence or “being there” in the virtual environment. This involves connecting our senses and physical movements with the simulated world of VR (Zheng et al., 1998). VR environments potential for creating deeply immersive and interactive experiences opens new possibilities for research.

Neuroticism and Extraversion Explained by The Five Factor Model (FFM)

The FFM model organize personality into five basic traits using several sub-facets characterized by different behaviors and emotional patterns. The five main traits in the FFM model are Extraversion, Neuroticism, Conscientiousness, Agreeableness and Openness. According to the FFM your personality is made up by a combination of your score on these five traits (McCrae & John, 1992).

This study will focus on the two traits extraversion and neuroticism, and how they influence the participants movement patterns. Extraversion is a personality trait characterized by assertiveness, sociability, and expressiveness. An individual with a high score on extraversion has no problem with being the center of attention, thrives in social situations and often prefer active engagement with the external world (Kennair & Hagen, 2015). A high score on neuroticism indicates higher emotional instability and tendency to experience negative emotions more intensely and frequently than others. People with a high score on neuroticism is more sensitive to environmental stressors, often resulting in a more cautious demeanor (Kennair & Hagen, 2015).

Movement

Movement can be described as activity, the development of action or actively changing positions by moving or being moved (Radovancević, 2007). Based on observations during movement activities, psychomotor therapy assumes that people move according to their personality. This form of therapy is based on the understanding that physical movement and emotional, mental and behavioral patterns are interconnected (Van Coppenolle et al., 1989). Psychomotor therapy uses movement, physical activity, and body awareness as a therapeutic approach to psychological ailments. An important premise for this type of therapy is that one's physical state can lead to changes in one's mental state, and vice versa (Probst, 2017). This suggest that movement can be a manifestation of a person's mental state, which indicates that aspects of a person's personality also could be shown trough their movements. Being exposed to a VR-environment that evokes nervous reactions can trigger the participants to act and move accordingly (Kisker et al., 2021) possibly revealing aspects of their personality.

Multiple different aspects of movement could be investigated, however this study wanted to look at indicators of how fast and how much the participants move in the VR-environment. These factors could reveal a lot about the participants movement patterns and exploration behavior in the environment. Earlier findings and existing literature indicate that the specific personality traits neuroticism and extraversion could influence speed and movement patterns (Delgado-Gómez et al., 2022; Kisker et al., 2021). Therefore, average speed and composite score was elected as the movement measurements further explored by the present study, since these variables were the best fitting indicators from the data to provide information about participants average speed and overall movement.

Movement and Personality

Personality and movement are each important human characteristics that have been studied much separately, however there are limited existing research that investigates how movement and personality interact with each other (Brebner, 1985). The increased use and credibility of virtual reality experiments in the field of psychology can create new possibilities to further explore if personality manifest in movement and body language, and how this is expressed in a virtual environment. As early as in 1933, Allport and Vernon pointed out a relationship between personality and expressive movement, indicating that movement could be a potential predictor for personality (Allport, 2016). Recent studies have begun to further investigate the relationship between personality traits and physical movement, such as the study by Delgado-Gómez et al. (2022) which proposes using movement to predict and assess personality. The study investigated participants movements during an interview, and results showed that the most extraverted participant exhibited greater head displacement than the least extraverted participant when answering questions about themselves (Delgado-Gómez et al., 2022).

It has also been demonstrated that observers attribute intentions, personalities and emotions to moving geometric figures (Koppensteiner, 2011). Research on person perception indicates that nonverbal cues such as posture and expressions often are perceived as expressing personality traits (Naumann et al., 2009). Even though this is not directly connected to movement, it shows that we assign characteristics to motion cues, and one can speculate that this indicates a relationship between movement and personality. If aspects of personality can be perceived and attributed to moving objects and motion cues, it seems reasonable to assume that we also interpret people's movements as reflections of their personality. This suggests that personality traits can manifest through distinct movement patterns. Another study that supports these findings is Halovic and Kroos examination of emotion specific gait-kinematics which point out that many movement cues convey significant information about a person's emotional state, and consequently their personality (2018).

Based on this research it may be fair to assume that different manifestations of individuals behavior, such as movement, are expressions of their internal psychological characteristics, linked to their personality. This is further supported by Kisker, Gruber, and Schöne's research on behavioral realism in virtual reality that demonstrates how virtual environments can evoke lifelike responses mirroring real-world behavior and personality driven reactions (2021).

Given that anxiety and emotional responses are often linked to personality, it may be reasonable to assume that personality traits also influence behavior in a VR-environment, based on the results of this study.

Objective of The Present Study

The objective of the current study aimed to explore the relationship between personality and movement within a virtual reality setting. Investigating the connection between specific movements in VR and participants personality scores can enhance the understanding of underlying psychological dynamics. This approach allows for a deeper interpretation of how associations between movement and personality identified in previous research manifests in the interactions observed in the present study. This resulted in the following research question: *"Do specific personality traits influence participants movement patterns and exploration behaviors within a VR environment?"* Based on exciting literature and the research question, the following hypotheses was developed:

Hypothesis 1: Individuals with a higher score on Neuroticism will demonstrate slower average speed in the negative VR-environment.

Hypothesis 2: The movement patterns of individuals with a higher score on Neuroticism will show reduced mobility and activity in the negative VR-environment.

Hypothesis 3: Individuals with a higher score on Extraversion will demonstrate higher average speed in the negative VR-environment.

Hypothesis 4: The movement patterns of individuals with a higher score on Extraversion will show greater mobility and activity in the negative VR-environment.

Hypothesis 5: The combination of an individual's scores on the personality traits Neuroticism and Extraversion can influence their movement patterns in a VR-environment.

Hypothesis 6: The combination of an individual's scores on the personality traits Neuroticism and Extraversion can influence their average speed in a VR-environment.

Neuroticism and Extraversion are two of the more prominent personality traits. The results from the study by Kisker et al. showed that the participants anxiety level could affect their behavior in a virtual reality setting, resulting in slower walking speed when they experienced a higher level of anxiety (2021). Since neuroticism are closely connected to anxiety and stress (Kennair & Hagen, 2015), *Hypothesis 1* suggested that a higher neuroticism score would predict reduced average speed in the negative VR-environment. *Hypothesis 2* suggested that the participants with a higher neuroticism score will have less movement in the negative environment, as the results from Kisker et al. (2021) arguably could indicate this, and the environment was meant to make participants feel anxious.

The study by Delgado-Gómez et al. (2022) indicated that individuals with a higher extraversion score exhibit more movement than individuals with a lower score. A meta-analysis and literature review looking for connections between physical activity and personality traits, found a correlation between higher scores on extraversion and being physically active (Rhodes & Smith, 2006). Considering that movement is a fundamental part of physical activity, it could be reasonable to assume that participants scoring higher on extraversion are likely to exhibit more movement. Extraversion is associated with higher levels of sociability and energy (Kennair & Hagen, 2015). These traits could lead to increased physical activity in an observed setting requiring interaction such as a VR-environment. Based on these findings *Hypothesis 3* and *Hypothesis 4* was established. Lastly, *Hypothesis 5* and *Hypothesis 6* wanted to investigate if the combination of the personality traits neuroticism and extraversion had a predictive effect on movement and speed in the VR-environment.

Methods

Sample/Participants

The data utilized in this study was collected as a part of the study PLURAL founded by the Norwegian University of Science and Technology (NTNU). The study included 47 participants, that mainly consisted of students from NTNU. The age criteria for the participants were set at 18 to 35 years old. The study got approved by “Sikt,” the Norwegian knowledge sectors service provider (reference number: 494059). Participants gave their informed written consent and reported no psychological or neurological disorders before participating in the experiment. The exclusion criteria for the experiment included problems with being still in a closed room over a longer period of time, being diagnosed with any sort of seizure disorder or schizophrenia and being newly diagnosed with depression or an anxiety disorder. The criteria also stated that participants could not have trouble with sudden dizziness or unconsciousness without a known cause. They could also not be on any medication that effected the central nervous system, nor have consumed any alcohol the last twelve hours. Finely the exclusion criteria included that the participants could not actively be in therapy, have gotten therapy recommended by close relations or have considered going to therapy in the last five years. They also reported gender and earlier experience with virtual reality before answering the questions. The sample consisted of 30 women, 15 men and 2 participants who did not specify their gender. The participants were recruited through convenience sampling by the students conducting the experiment. Several participants were excluded from the movement part of the data, but none were excluded from the questionnaire part. The final sample with the complete data including the movement variables comprised 38 participants (26 women, 11 men and 1 unidentified), as nine were excluded due to issues with their movement data during the experiment. Exclusions were made either due to deviations from the study’s guidelines or because participants did not complete the experiment.

Virtual Reality Environment

The virtual reality scenarios were designed using Unity version 2021 .3.33f1. The scale of the VR environment in reality was 6 meters vertically by 5 meters horizontally. The assets in Unity used to design the two scenarios were “Medieval Fantasy Ruins – Dark Forest

Environment - 3D Fantasy”. In addition, “Mountain Environment – Dynamic Nature - 3D Vegetation” were also used on the neutral environment. High-Definition Render Pipeline (HDRP) was used in Unity, this is a scriptable render pipeline that makes it possible to create cutting-edge, high-fidelity graphics on high-end platforms. The scenarios were explored using SteamVR 2.4.3. To get Steam and Unity to communicate “SteamVR plugin – Integration” was utilized. The VR environment consisted of two scenarios: a neutral scenario and a negative scenario. Figure 1 illustrates the setup for the neutral environment, while the setup for the negative environment can be seen in figure 2 below. There were also incorporated different sound effects for each scenario to further enhance the atmosphere of the environments. The two environments consisted of the same route and were almost identical except from the different visuals and sound effects. For this experiment the Vive Pro 2 VR headset was utilized. The headset tracked the participants movements and offered full 3D vison and a 360° view. In addition to the headset, trackers were placed on the participants wrists and ankles to capture their different body movements. The trackers utilized for the movement measurement in this experiment are called HTC Vive Tracker 3.

Figure 1.

Representation of the Neutral VR-Environment

Figure 2.

Representation of the Negative VR-Environment

Measurements

The self-reporting questionnaire included items from different validated scales designed to assess various aspects of personality, emotion regulation and fear responses. Additionally, the questionnaire included measures to evaluate immersion and presence, alongside questions about the participants experiences with virtual reality. IPIP-120 was used to measure thirty facets of the Five Factor Model using 120 items. The instrument measured the five different personality traits: extraversion, neuroticism, openness, agreeableness, and conscientiousness. Participants responded to the questions by rating the statements on a five-point Likert scale ranging from “strongly disagree” to “strongly agree.” This study used a Norwegian translation by Pran (2021) based on the original English version (Johnson, 2014). The present study was primarily interested in participant’s scores on extraversion and neuroticism. The internal consistency of these personality traits was examined and demonstrated high reliability. The extraversion subscale consisted of 24 items, with an internal consistency of $\alpha = .85$. Similarly, the neuroticism scale also consisted of 24 items, and showed an internal consistency of $\alpha = .88$.

To measure movement in the context of this experiment, Principal component analysis (PCA) served as a tool to interpret and simplify the movement data collected. The sensors on the participants hands, feet, and head-mounted display (HMD) tracked their movements while they navigated trough the VR scenarios. Principal component analysis was used to detect dominant patterns in the movement data, essentially PCA represent the participants average movement patterns in the VR environment (Wold et al., 1987). This study chose to investigate the participants movement in the negative VR condition, and therefor only utilized the variables measuring movement in the negative VR-environment. The composite score is a single metric derived from the PCA scores that captures the degree to which each participant’s movement aligns with this dominant pattern during the VR scenarios. It provides information about the participants emotional engagement and reactions to the VR environment. High composite scores suggest that the participants movement aligns with the emotional movement pattern identified by the PCA. In the negative VR environment, a pattern could be exhibiting increased alertness or adopting defensive postures like pulling their hands closer to their body. The participants composite score indicates how much they deviate from the average movement pattern in the negative environment identified by PCA, where a higher score indicates that they follow the pattern, and a lower score indicates that they deviate a lot from the pattern. Based on the literature and previous findings (Kisker et al., 2021), this study assumes that the dominant movement pattern identified by PCA will correspond to reduced movement, exhibiting less mobility and activity in the negative VR-environment. Therefore, composite score is used as an indication of how much the participants will move in the VR-environment, and a higher composite score will thus correspond with reduced movement, since this is the predicted dominant movement pattern in the negative VR-environment.

The average speed variable measured the participants movement speed within the negative VR environment, with data collected using the HMD as a tracking device. The head-mounted display registered how fast the participants moved around in the room, which was used as a measure for their average walking speed in the negative VR-environment. The scenario did not have any surprising fear stimuli, which could abruptly impact the participants movements. However, these measurements provide information about the participants movement patterns while exploring the VR-environment, under exposure to an unknown negative condition designed to create fear anticipation.

Design and Procedure

Before entering the VR-environment, the participants gave their consent to participate in the electronic form. The study got approved by Sikt, the Norwegian knowledge sectors service provider (494059) before moving forward with the experiment. The participants started by responding to a detailed questionnaire. The first section of the questionnaire included the IPIP-120, which assess personality trough 120-items, and an additional 20 questions about emotion regulation and behavior before exploring the VR environment. These questions included 10 items from the RST-PQ, specifically regarding the Fight-Flight-Freeze System (Corr & Cooper, 2016) and another 10 items from the ERQ focused on emotion regelation strategies (Gross & John, 2003). The RST-PQ was translated into Norwegian by the researchers for this study, while an existing Norwegian version of the ERQ from an earlier study was employed. Following the participants VR experiments, they completed the remaining questionnaire items mainly consisting of questions concerning their VR experience. This part of the questionnaire included questions from the Immersive Virtual Environment Questionnaire (IVEQ) to evaluate immersion and presence (Schubert et al., 2001; Tcha-Tokey et al., 2016). In this study the Norwegian translation by Lønne et al. (2023) was utilized. The participants were led into a room where they answered the first part of the questionnaire. The participants answers got registered with an anonymous code, to assure their privacy and anonymity. After filling out the form, the participants were taken into the experiment room where they got instructions and information about how to continue with the experiment. The participants were given neutral slippers to eliminate the effect different footwear could have on the movement variables. Four tracking sensors were placed on the participants ankles and wrists. The trackers were placed one on each arm, and one on each leg as illustrated in Figure 3. The sensors and the VR headset was used to track the participants movement and created the data for the different movement variables used in the analysis.

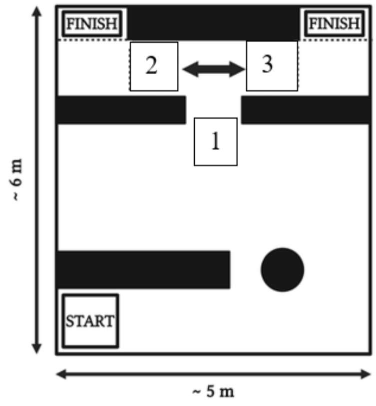
The participants were exposed to two different VR scenarios. One of the scenarios were designed to be neutral, and the other one were designed as a negative condition meant to be scary. It was randomly assigned which scenario the participants went into first. They got instructed to find the way out by walking around in the environment until they found a sign with “Level complete” written on it (see Figure 1). After the participants succeeded to find their way out, they were led back to the starting point where they started the rout over again. The second time the participants explored the other scenario with exactly the same instructions to execute the same task as last time. Figure 4 illustrates the rout the participants had to navigate through in the VR environment. To find the “Level complete” sign, the participants had to walk through a narrow hallway with two different paths. For the sign to appear, the participants had to try both options. The numbers showed in the figure illustrates where the participants had to move for the sign to appear. When they got to point 1, they had to choose moving left or right. If the participants started by choosing option 2, the path turned into a dead-end, so they had to try option 3. It did not matter if they tried option 2 or 3 first, however they had to try both options for the sign to reveal itself. The two numbered boxes illustrates where the participants had to move for the "Level complete" sign to appear. The reason the participants had to try both options before the sign appeared was to accumulate more movement used to create valuable movement data for the analysis. After the participants had finished both scenarios, they went back to the first room to finish the questionnaire and get information about their rights to withdraw from the project, and the project in general.

Figure 3.

Illustration of Participant with Equipment

Figure 4.

Outline of the VR-Scenario



Statistical Analysis

After the experiment were conducted, the answers and data the participants had provided were collected. The data was analyzed using IBM SPSS Statistic Version 29. For the descriptive analysis mean, standard deviation and frequency was extracted to summarize the sample data. To analyze if there were any correlations between the variables, a Spearman's rho correlation was performed. Spearman's rho was used because a Shapiro-Wilk test of normality revealed that not all the variables were normally distributed, which called for a non-parametric test suitable for data that do not meet the normality assumptions (Field, 2018).

Furthermore, two separate multiple regression analysis were conducted to investigate whether the personality traits neuroticism and extraversion could predict composite score and average speed in the negative VR-environment. The first regression analysis used average speed in the negative environment as the dependent variable, while the independent variables were neuroticism and extraversion. However, in the second regression model the dependent variable were exchanged with the composite score in the negative environment. The independent variables remained the same. To further investigate the predictive value of the individual personality traits on the different movement variables, four simple linear regression analyses were conducted.

The statistical assumptions underlying regression analysis were investigated. Independent errors were controlled by inspecting the Durbin-Watson tests for the regression models, which showed satisfactory results. Multicollinearity was assessed by inspecting all variance inflection factor (VIF) values, which were within acceptable limits (Field, 2018). Visual inspections of the histograms and P-P-plots were preformed to assess for homoscedasticity and normality of the residuals. A Shapiro-Wilk test of normality was performed on the standardized residuals to further validate the assumptions of normality. The standardized residuals of the multiple regression models showed tendencies of not meeting the assumptions for normal distribution, which should be considered when interpreting the results.

Results

The result of a Spearman’s rho test indicated a moderate negative correlation between Neuroticism and Extraversion $r(36) = -.40$, $p < .013$. There were also found a moderate negative correlation between Neuroticism and Average Speed $r(36) = -.41$, $p < .010$. This indicates a relationship between higher scores on Neuroticism and lower scores on average speed between the 38 participants, which suggests that participants with a higher score in neuroticism walked slower in the negative VR environment.

Table 1

Descriptive Statistics and Spearman’s Rho Correlation Between Study Variables (N = 38)

Variable	*M*	*SD*	*N*	1	2	3	4
1. Neuroticism	2.37	.48	38				
2. Extraversion	3.55	.41	38	-.40**			
3. Composite Score	1.37	.22	38	.16	.09		
4. Average Speed	0.45	.11	38	-.41**	.03	-.25	

*$p<.05$ **$p<.01$.

The overall model using Average Speed as the dependent variable was not statistically significant, $R^2 = .12$, $F(2, 35) = 2.36$, $p = .109$. However, when the predictors were assessed individually in a simple linear regression, a statistically significant negative relationship was found between neuroticism and average speed, $R^2 = .12$, $F(1, 35) = 4.77$, $p = .035$. The standardized beta value indicated that neuroticism and average speed were negatively associated, β = -.34, $p = .035$. Extraversion did not indicate a significant effect, $R^2 = .01$, $F(1, 35) = .43$, , $p = .519$. An assessment of the standardized beta values further supported this β = -.11, $p = .519$.

Table 2

Regression Coefficients Predicting Average Speed (N = 38)

Variable	*B*	*SE B*	β	R^2	*F*
Simple effects					
Neuroticism	-.08	.04	-.34	.12*	4.77
Extraversion	.03	.05	.11	.01	.43
Model				.12	2.36
Neuroticism	-.08	.04	-.36		
Extraversion	-.01	.05	-.05		

*p<.05 **p<.001.

The regression model using Composite Score as the dependent variable were not statistically significant, $R^2 = .02$, $F(2, 35) = .29$, $p = .749$, suggesting that none of the current predictors were significant predictors for the Composite Score. A Simple linear regression analysis of the individual predictors revealed that neither neuroticism, $R^2 = .01$, $F(1, 35) = .25$, β = .08, $p = .618$, or extraversion, $R^2 = .00$, $F(1, 35) = .10$, β = .05, $p = .755$ significantly predicted the Composite Score.

Table 3

Regression Coefficients Predicting Composite Score (N = 38)

Variable	*B*	*SE B*	β	R^2	*F*
Simple effects					
Neuroticism	.04	.08	.08	.01	.25
Extraversion	.03	.09	.05	.00	.10
Model				.02	.29
Neuroticism	.06	.09	.13		
Extraversion	.06	.10	.11		

$^*p<.05$ $^{**}p<.001$.

Discussion

The aim of this study was to investigate the relationship between personality and movement and answer the research question "Do specific personality traits influence participants movement patterns and exploration behaviors within a VR environment?". The goal was to find meaningful information that could be used for further research, and hopefully impact the understanding of how these variables interact and affect each other. There are few existing studies that implicit investigate this relationship, and almost none that use virtual reality as a research tool. The study chose to only focus on neuroticism and extraversion when assessing personality, and if these two personality traits specifically could predict the participants movement patterns and exploration behaviors within a negative VR-environment.

The results from this study could not conclude that extraversion and neuroticism had a tangible impact on participants movement in the VR-environment. However, the results from the correlation analysis and assessment of the simple effects indicated that neuroticism could somewhat predict slower average walking speed in the negative VR-environment. The results revealed that neuroticism had a weak but significant effect on average speed, while no significant relationship was found between neuroticism and the composite score, nor did the results find any significant effects between extraversion and any of the two movement variables. This suggested that extraversion had little to no predictive value on the movement variables utilized in this study.

Neuroticism – and Identified Movement Patterns

The first hypothesis assumed that there was an association between individuals with a higher neuroticism score and slower average speed in the negative VR-environment. The Spearman's rho correlation analysis found support for this assumption, which indicated a significant negative relationship between the two variables. The results from the average speed regression analysis (see table 2) indicated an association between higher neuroticism scores and slower walking speed in the negative environment, based on the assessment of the simple effects. These results are supported by earlier findings (Kisker et al., 2021), which indicated an existing association between slower walking speed and reported higher anxiety levels triggered by a stressful condition in a virtual environment.

The second hypothesis assumed that individuals with a higher score on neuroticisms would exhibit reduced mobility and activity in the negative VR-environment. Given that the dominant movement pattern in the negative VR-environment was assumed to be characterized by more cautious and restrictive movements, the second hypothesis suggested that individuals with a higher neuroticism score would align more with the composite score, exhibiting less mobility and activity. The results did not find any support for the second hypothesis. This suggests that while neuroticism may influence certain aspects of movement, such as average speed, it may not be a significant predictor for other dimensions of movement like the overall movement pattern in a VR-environment.

Extraversion – and Identified Movement Patterns

The third hypothesis suggested that higher scores on extraversion would be associated with higher average speed in the negative VR-environment. The Spearman's rho correlation analysis found no indication of an association between extraversion and average speed. The multiple regression analysis investigating average speed did not reveal supporting results for the third hypothesis either. Furthermore, none of the results supported the hypothesis, indicating that extraversion had little to no effect on the walking speed of the participants in the VR-environment.

The study could not find any evidence supporting hypothesis 4, which proposed that participants with a higher extraversion score would exhibit greater mobility and overall activity in the negative VR environment. The assessment of the simple effects from both regression models, did not show any support for either of the hypotheses including extraversion as a predictor. The results from this study indicate that extraversion is not a strong predictor for average speed or the overall movement pattern in the negative VR-environment. The findings suggests that extraversion may not have a strong connection to the type of behavior captured by these specific movement variables. It is possible that extraversion influences other aspects of behavior not measured by the movement variables researched in the present study. Delgado-Gómez et al. (2022) identified several movement patterns that characterized personality traits from the FFM. The study in question discovered that higher scores on extraversion was connected to movement patterns expressing higher mobility. However this was in the context of an interview setting, so the findings could have been affected by the social setting and verbal interaction in the study, causing higher engagement among the highly extraverted participants. These factors are less relevant in a solidary VR-setting and may be why this study could not replicate the findings.

The Combined Predictive Effect of Neuroticism and Extraversion on Movement

Hypothesis 5 and Hypothesis 6 was not confirmed since none of the multiple regression models including both extraversion and neuroticism were statistically significant. This indicated that the two personality traits had little to no predictive value on either average speed or composite score when combined. The two hypotheses were based on the previously mentioned literature and earlier studies used to explore the prediction value of the individual traits, however these hypotheses wanted to assess the jointed predictive value of neuroticism and extraversion on the movement variables. The results did not reveal any significant relation, indicating an overall poor fit of the two regression models. This ultimately implies that earlier findings expressing a relationship between extraversion, neuroticism and movement were unsupported by the current study.

Limitations and Strengths

Several strengths and limitations can be identified regarding the present study. The experimental design of the study aimed to establish a consistent baseline for all the participants and standardize the conditions for the participants experience in the VR-environment, and thereby enhancing the reliability of the findings (Meltzoff & Cooper, 2018). The design required participants to move within the environment, creating a setup allowing a more controlled investigation of how personality traits may influence movements in a VR setting. The control provided by an experimental approach reduced the impact of other influential factors, such as the use of standardized footwear. This increased the likelihood that any effects found could in fact be attributed to the participants individual personalities.

Another considerable strength is the use of well-established measurement instruments. The use of IPIP-120 for assessing personality traits alongside the technology of the motion tracking devices capturing movement, gives this study a high degree of measurement validity. The IPIP-120 inventory has been tested and used before in multiple earlier research, and shown to be a valid instrument to assess personality according to the FFM-model (Johnson, 2014). Furthermore, the innovative use of VR to explore the relationship between movement and personality offers a novel angle which has not been explored by previous studies, thereby making this research a valuable contribution to the field.

The study also has notable limitations. The relatively small sample size in this study ($N = 38$) may contribute to hide or weaken effects that potentially could have been detectable in a larger population (Field, 2018). Since the results indicated a correlation between neuroticism and average speed in the negative environment, and the simple effects from the regression analysis also suggested a weak predictive effect of neuroticism on average speed, a larger sample size could potentially clarify whether neuroticism actually is a significant predictor. The fact that the residuals were not normally distributed limits the credibility of the results from the regression analysis, however this may be a ripple effect of the small sample size.

The study was also limited by extraneous factors that could possibly have influenced the movement measurements. The VR-headset was attached to a wire, which might have disrupted the participants movements. When the participants navigated around the room while wearing the headset, they occasionally needed to adjust their movements to accommodate the wire. Situations where they had to interact with the wire by moving it from one side to the other or stepping over it did occur. These adjustments might affect their natural responses and movement patterns within the VR-scenario. Furthermore, the disturbance caused by the wire may have diminished their sense of immersion in the VR-environment, potentially affecting the authenticity of their reactions and movements in response to the virtual environment. Additionally, the authenticity of the participants reactions could also possibly have been influenced by their awareness of being observed by the students during the experiment.

Implications and Further Research

This study brings forth several practical and theoretical implications, both in terms of knowledge and future extending research. The findings from the present study demonstrates that VR technology can offer valuable insights into psychological concepts and their interactions. The absent of support for most of the hypotheses, implies that the specific personality traits investigated in this study – neuroticism and extraversion – did not significantly predict the average walking speed or movement pattern within the VR-environment. The support found for hypothesis 1, which suggested a relationship between neuroticism and average speed, opens for further investigation. The fact that the results showed little supporting evidence for the research question could indicate that these specific personality traits do not have a significance influence on individuals movement patterns and exploration behaviors within a VR-environment. However, this does not exclude the possibility that personality traits can be an influence factor for movement patterns, but that the setup of this study was a poor or imprecise way to assess the relationship between movement and personality.

Despite little support for the hypotheses, several calls for further research can be made. Firstly, recreating the experiment with a bigger sample size can contribute to normally distributed residuals, making the regression analyses more valid and efficient (Field, 2018). A bigger sample size could also help revealing if the results supporting hypothesis 1 was due to coincidence, since the results indicated a significant effect between neuroticism and participants walking speed in the negative VR-environment. Earlier research like the study by Kisker et al. (2021) with similar findings supports these results and indicates that the weak significance could be due to the small sample size or other limitations with this study.

One could also research if extraversion and neuroticism have better predictive value on other aspects of movement than the measures utilized in this experiment. This could either be done by exploring other movement variables, or by using different movement measures. It could also be interesting to investigate if other VR conditions than the environment utilized in this study would be more suitable to further explore the relationship between movement and personality. Another idea could be to further investigating if other personality traits from the FFM like agreeableness, conscientiousness or openness are better predictors for movement. The study of human motion is of interest to numerous disciplines, including psychology and human computer interactions (Aggarwal, 2005), where the present study can provide valuable knowledge and be a source of inspiration for several new research. Even though this study found little support for the hypotheses, it does not eliminate that it is feasible to assess an individual's personality through their movements, although this needs further investigation.

Conclusion

The aim of this study was to provide insights into the complex relationship between personality traits and their manifestations in movement within a virtual environment. Recent advancements in VR technology have opened for exciting, innovative ways to do psychological research. This facilitates new methods to explore the relationship between movement and personality, a field with limited existing research. Although a weak significant relationship was found between neuroticism and average speed, suggesting that participants with higher neuroticism scores may exhibit slower walking speed in a negative VR-environment, the overall impact of personality on movement patterns and exploration behavior within the virtual reality setting of this study appeared to be limited. The results did not support the assumptions that neuroticism and extraversion could predict movement within the VR-environment. As previously noted, researching the relationship between personality and movement is challenging due to the complexity and multifaceted nature of both concepts. Future research should aim to further explore this relationship by using larger sample sizes and consider including additional aspects of personality and movement. Exploring this relationship further could provide a more comprehensive understanding of the dynamics between these constructs, thereby giving deeper insights to the feasibility of assessing personality through movement.

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Appendix

AI-Declaration:

Deklarasjon om KI-hjelpemidler

Emne og type dokument: PSY2910 Bacheloroppgave

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- ☐ Nei

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Solveig M. Sætre 11.05.2024, Trondheim

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