8-17-2022 10:00 AM

Virtual Reality, Mindfulness and Their Associations to Personality Traits

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A thesis submitted in partial fulfillment of the requirements for the Master of Arts degree in Psychology

Abstract

Mindfulness, conceptualized as actively noticing and engaging with oneself and one's surroundings with a nonjudgmental mind, has been found to be associated with many positive outcomes such as healthy relationships, stress reduction, performance engagement, and increased well-being. Virtual reality (VR) technologies offer people immersive experiences to engage with novel environments for entertaining and therapeutic purposes. While in any VR environment, participants may perceive themselves as if they are in the scenes, that is, they experience moment-to-moment awareness and immersion in these virtual environments. Thus, practicing mindfulness meditation with technologies like smartphones and VR have become increasingly popular over the past decade, however little research has examined VR and mindfulness separate from meditation. Further, meditation does not appeal to everyone and may even be an adverse experience for people with traumatic histories, thus research examining other ways to cultivate mindfulness is necessary. The current research examined 654 self-report responses regarding people's VR experiences, personality, and well-being to determine if general VR use was associated with increased mindfulness, and explored if specific personality traits such as openness, empathy, and immersive tendencies was associated with increased VR use and mindfulness. Our results indicated that increased VR use was not associated with mindfulness, but participants who rated high on their subjective VR experiences (e.g., feelings of self-expansion, presence, enjoyment) scored high on mindfulness. Mindfulness itself predicted well-being, but VR use did not and there was no interaction between VR use and mindfulness. Suggestions for how to guide future VR research on mindfulness are provided.

KEYWORDS: virtual reality, mindfulness, well-being, personality

Summary for Lay Audience

Mindfulness has been found to be associated with many positive outcomes such as healthy interpersonal relationships, stress reduction, and increased well-being. Practicing meditation to cultivate one's mindfulness has become increasingly popular and accessible with recent technologies like smartphone apps and virtual reality (VR) headsets. VR involves computer visualization of a simulated (virtual) environment (e.g., nature scene) presented using a head-mounted display (HMD), typically together with accompanying audio (e.g., birds chirping) and these technologies provide people access to individual or social meditation sessions. However, meditation may not appeal to everyone. Beyond simple disinterest, meditation does not appeal to everyone and may even be an adverse experience for people with traumatic histories. While mindfulness and meditation are sometimes used synonymously, it is crucial to note that mindfulness is conceptualized as actively noticing and engaging with one's emotions and reactions to everyday events with an open, nonjudgmental mind and meditation is the training of one's attention, which helps to cultivate mindfulness. While VR technology provides an immersive environment and removes external distractions, few researchers have connected mindfulness to VR use. Furthermore, personal dispositions may influence one's interest in VR use and mindfulness training, such as being high on openness. This research examined whether general VR experiences could promote mindfulness and improve well-being because this technology allows people to have novel and fascinating experiences within the context of their choice. Furthermore, this research investigated whether personality traits such as openness, empathy, and immersive tendencies were associated with VR use and mindfulness.

Acknowledgments

I would like to take this opportunity to thank my thesis advisor, Dr. Lorne Campbell, for all of his guidance and support over the past year. He was always interested and invested in my study, which allowed me to expand my interests and curiosity freely, as every question was answered enthusiastically, and both of our ponderings led to interesting discussions. And of course, to all my friends and family who provided nonjudgmental support throughout these past two years and encouraged me to continue my academic studies beyond my undergraduate degree, which I am proud that I did. All of the supportive people in my life have helped me accomplish as much as I have now and have my appreciation as I go forward.

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Table of Contents

List of Tables

List of Appendices

Chapter 1: Introduction

1. Introduction

Mindfulness, meaning sustained awareness of one's body, thoughts, feelings, and environment (Langer 1989; Langer 2009), has become a topic of exponential interest in various research fields over the past couple of decades, especially to social scientists as continual evidence has demonstrated many psychological and physical benefits associated with mindfulness. For instance, stress reduction, cognitive and motor performance enhancement, and improved health and life satisfaction have all been associated with mindfulness (Baer, 2004; Langer, 2009; Vonderlin et al., 2020). Improving one's mindfulness can be achieved in multiple manners, from the most traditional mindfulness meditative practices to emerging mindfulness skills-based training, which has become increasingly accessible and popular with mobile applications for smartphone users. A more niche area of mindfulness research has examined utilizing virtual reality (VR) immersive and enriching environments to support mindfulness practice (Navarro-Haro, 2017). In fact, some researchers (see Seabrook et al., 2020; Kosunen et al., 2016, for example) have proposed that VR may be an appealing option for meditation and other mindfulness practices (e.g., relaxation training, yoga) for individuals who may struggle with traditional meditation practices, such as people with traumatic histories, as they are more at risk for adverse meditative experiences (i.e., feeling distressed; Lindahl et al., 2017, 2020), but little research has examined how more general uses of VR could still promote mindfulness, for example, gameplay or interacting with awe-inducing environments (e.g., nature scenes). VR use has been found to be strongly associated with feelings of presence and immersion (Slater, 2018), openness (Jacques et al., 2009), and engrossment (Shelstad et al., 2017), which all relate to the conceptualization of mindfulness (i.e., actively noticing new things within oneself introspectively and engaging with one's present environment) however, these potential

connections have not been examined. Thus, more research is needed to understand the associations between VR use and mindfulness, compared to meditation practice and mindfulness, as well as further investigate who may be more drawn to alternative potential mindfulness practices like VR use, perhaps based on their personal dispositions.

1.1 Mindfulness

Theoretically, mindfulness is typically conceptualized into two main non-independent yet distinct definitions: Eastern-rooted, which focuses on moment-to-moment awareness that is nonjudgmental towards the self (see Kabat-Zinn, 1982, 1990), and Western-rooted, based on Ellen Langer's social psychological conceptualization, defining mindfulness as openness to experience, novelty and adjusting to variability (see Langer 1989; Langer & Piper, 1987). The Western-rooted Langerian definition has been embraced and used in social psychological research to examine mindfulness in a variety of contexts.

Indeed, Ellen Langer theorized mindfulness to be a socio-cognitive ability and coined the term Langerian mindfulness, denoted as openness to experience, engagement, novelty seeking, and shifting perspectives (i.e., being psychologically flexible and adaptive) (Langer et al., 1978; Langer & Moldoveanu, 2000). This definition classifies mindfulness, in essence, as paying attention to novelty in the present with an open mind (Langer 1989, 1997). Langerian mindfulness has been examined in a variety of contexts such as educational, therapeutic, vocational, and cognition. For example, research on autism spectrum disorder (ASD) has incorporated a Langerian theoretical framework since she promotes mindfulness as a mindset that is rooted in "fostering a creative, divergent, and non-algorithmic mode of thinking" (Poquérusse, Pagnini, & Langer, 2020, p. 78). Mindfulness training promotes attending to sensory symptoms and identifying emotions, thus encouraging attunement to inner changes, and

distinguishing these emotions and sensory changes, which helps reduce one's overall emotional reactivity intensity (Watford & Stafford, 2015). Additionally, there may be many social benefits associated with increased mindfulness, including greater emotional awareness and higher quality relationships (with romantic partners, friends, colleagues). For example, Burpee and Langer (2005) concluded that mindfulness has implications for marital satisfaction and well-being, with partners higher in reported mindfulness reporting higher satisfaction and overall well-being. Furthermore, Don (2020) argued that individuals high in mindfulness are more likely to endorse the growth belief (i.e., that relational problems can be maintained and overcome), which in turn, influences relationship satisfaction and feelings of connectedness.

Another area extensively studied using a Langerian framework is the work-related benefits of increased mindfulness. Studies have demonstrated that those higher in mindfulness (e.g., greater awareness of one's environment, heightened presence, openness, and adjustability) are more likely to have sharpened cognitive acuity, productivity, creativity, and performance (Langer & Moldoveanu, 2000; Pirson, 2012). More generally, research on mindfulness in the workplace has examined a variety of occupations, from the fast-paced, stressful environments restaurant servers are exposed to daily to the more relaxed office setting jobs, and has consistently demonstrated that mindfulness is associated with every worker's overall well-being (Dane & Brummel, 2014; Dunoon & Langer, 2011). Most of this research focuses either on mindfulness meditation practices or mindfulness skills training workshops (especially for educational and organization research) as methods to examine participants' mindfulness, which may be great methods, however, do not appeal to everyone, and will be discussed at length in a later section. To sum, the benefits of mindfulness are circulating and social psychology literature, yet the methods to improve one's mindfulness have not been thoroughly explored, apart from

meditation which has had the spotlight in mindfulness research for decades and will be briefly overviewed in the next section (Britton et al., 2021).

1.2 Meditation

Meditation is arguably the most common practice to increase one's mindfulness and is traditionally taught in person, however, practicing meditation has become more popular and accessible with technologies like smartphone apps and virtual reality headsets in recent years (Mani et al., 2015; Seabrook, 2020). Meditation is commonly tied to the Buddhist origins of mindfulness and is often examined using a Buddhist psychology framework (Keng et al., 2011). For instance, these technologies provide people access to individual or social meditation sessions, which is important as a key component of meditation is the experience of *sangha*, or the opportunity for social experience and community in meditation, typically achieved by having a trusted, compassionate, competent instructor (Husgafvel, 2018). However, research has emerged focusing on the social and well-being psychological benefits of meditating when people use apps and technology like virtual reality (VR). Several studies have demonstrated that VR applications aimed to improve mindfulness are related subsequently to increased well-being, which will be discussed further, in a later section (Crescentini et al., 2016; Keng et al., 2011). While VR has been incorporated into mindfulness meditation practices, research has yet to examine the associations between VR itself and mindfulness, without being a VR meditation practice (i.e., general VR use).

1.3 Mindfulness, Meditation, and Mental Health

Regarding mental health and well-being outcomes of having increased mindfulness, therapeutic, clinical, and social researchers have all highlighted the benefits of improved mindfulness in participants. These benefits include emotion regulation, decreased reactivity,

increased interpersonal connection, intrapersonal benefits such as enhanced immune functioning, self-insight, fear modulation, managing distractions more easily thus increased attention and presence, and lastly neuroplasticity (Farb et al., 2007; Davis & Hayes, 2011; Siegel 2009). In recent years traditional mindfulness-based therapies have been examined as interventions specifically for PTSD symptom reduction, and literature reviews reveal low attrition with medium to large effect sizes in PTSD studies (Boyd, Lanius, & McKinnon, 2018; Banks et al. 2015). Meditation is associated with a reduction in PTSD symptoms, as goals include deconstructing unnecessary cognitions, feelings, stressors and reducing goal or control-oriented behaviors.

A concern, however, is that research has also shown that individuals with histories of trauma often have difficulties meditating using typical techniques because intrusive thoughts, memories, and hypervigilance may interfere with their ability to direct their attention as they are intending, for example, toward breath sensations (Cebolla et al., 2017). Further adverse experiences during meditation have been extensively studied by Lindahl, Britton, and colleagues, who have found top reported distresses were out-of-body experiences, changes in self, affective changes, and cognitive changes, which all lead to feelings of fear, and that trauma histories were often identified risk factors for experiencing these adverse reactions to meditation (Lindahl et al., 2017; Lindahl et al., 2020; and Lindahl, Britton, et al., 2020). Further, Cebolla and colleagues (2017) found reports of distress while meditating were especially likely to occur during individual practice, when practicing focused attention meditation, and when meditation occurred for longer than 20 minutes. However, while mindfulness and meditation are at times used synonymously, meditation is only a vehicle or mode (albeit the most common) to achieve mindfulness, but other tools to increase mindfulness are important to examine as well.

1.4 Virtual Reality (VR)

Virtual reality (VR) allows people to have novel experiences in the context of their choice (e.g., own home, secluded outdoor space) through computer visualization of a simulated environment (e.g., a nature scene like the ocean or forest) presented using a headset, typically together with accompanying audio (e.g., nature sounds). These stimuli can either be "drawn" using graphics software or acquired from reality via 360° cameras (e.g., someone walking through the forest). In either case, while viewing such environments while wearing the headset, participants may perceive themselves as if they are in the scenes, that is, they experience a sense of mindfulness and immersion in these environments (Cipresso et al., 2018; Slater et al., 2018).

These feelings and perceptions are often also referred to as presence, however, to the diversity in this research, the term "presence" has been defined differently and its theoretical foundation can only be described as multi-layered and multifaceted (Mykota, 2017; Kreijns, Van Acker, Vermeulen, Van Buuren, 2014; Lowenthal & Dunlap, 2010), therefore the more succinctly defined term immersive tendency will be used for this research as it specifically refers to feelings of absorption, immersion, and presence in technologically mediated environments, including virtual reality (Witmer & Singer, 1998). Otherwise, presence in VR contexts is generally defined as a user's subjective sensation of "being there" in a scene depicted by a medium (Barfield, Zeltzer, Sheridan, & Slater, 1995), which is a vaguely subjective operational definition for a psychological variable.

Also, it is important to note that a sense of immersion may be evoked in varying degrees based on which media is being used and which aspect of presence is being assessed (i.e., assessing attention, interactive involvement, and physiological arousal, to name but a few) and VR should evoke higher feelings since there is more complex multisensory involvement. VR

research has focused primarily within less realistic contexts (often artificial environments such as gaming contexts), for example, being transported into a specific environment (e.g., a roller coaster, on the edge of a cliff) and individuals perceive themselves as truly being there, despite knowing it is not real, thus experiencing a high level of immersion. Even in simplistic or poorly rendered surroundings people in VR environments feel as though they are really there because one's perceptual system recognizes the environment nonetheless and engages accordingly (Stark, Rogowitz, & Allebach, 1995). For example, one study found that 10% of participants ran out of the room when immersed in a VR environment with a low graphic quality fire (Spanlang et al., 2007), and another found participants in VR near a precipice had elevated heartbeats, even to the extent of being considered "heart-pounding" responses (Meehan et al., 2002).

Since the late 1990s, research has evaluated the mental processes that allow individuals to become psychologically drawn into VR and maximize the experience of occupying virtual space. Key theorists have suggested higher immersive quality (i.e., better technology) will elicit greater feelings of spatial presence (Bowman & McMahan, 2007; Slater, Linakis, Usoh, & Kooper, 1996). However, for the public to have access to these technologies to experience the benefits of use, there must be a balance between cost/accessibility and high-quality technology. Thus, Cummings and Bailenson (2019) conducted a meta-analysis analyzing this relationship to determine how immersive VR technology needs to be accessible by the public and also achieve maximum feelings of presence. Overall, Cummings and Bailenson (2019) found a medium effect size on presence and individual features of immersion were found to vary. The most crucial individual immersive features were tracking level (i.e., natural movement in VR), stereoscopy (i.e., depth, 3D effect), and field of view (the more the better) to increase feelings of spatial presence in VR environments.

Therefore, theoretically, VR can be seen as a self-expansion tool to provide opportunities to engage in novel, exciting activities which broaden one's perspective. Socializing and connecting with others also seem to be a motive for using VR, especially paramount during the COVID-19 pandemic (Kohut & Campbell, 2021). Cummings and Bailenson (2019) also pointed out that most research is focused on isolated individual experiences in VR; therefore, research needs to also investigate aspects such as social presence and immersion when using VR with others.

1.5 VR and Mindfulness

In more recent years, research has emerged examining the benefits of practicing meditation in VR, such as Amores et al., (2016), who highlighted how awe-inducing VR experiences may improve user's mindfulness practices, such as meditating in immersive VR environments and learning mindfulness skills in environments where distractions are removed. Similarly, Kosunen et al., 2016 found VR systems to be great tools to promote deep relaxation, presence, and meditative states within immersive 360° environments. Amores and colleagues (2018) also proposed incorporating EEG headsets with VR meditation applications to further enhance people's experiences of awe, moment-to-moment awareness, and immersion (i.e., mindfulness). Specifically, VR systems provide enhanced levels of immersion due to multisensory integration, and depending on the quality of the system, may provide accurate, high-quality visual stimuli and responds to the user's reactivity (Arpaia et al., 2022). From a theoretical perspective, Hölzel et al., (2011) argued that body awareness (i.e., the phenomenon of interoception or truly "experiencing" the self accurately) is a fundamental mechanism for mindfulness and tools that promote body awareness (such as VR systems) are crucial to improving mindfulness. A review by Arpaia and colleagues (2021) examined VR teaching in

psychology, specifically guided meditation instruction and found that VR formats (whether computer generated or based on realistic environments) induce feelings of presence, immersion, and positive affect (see Seabrook et al., 2020). Thus, VR research should ask participants about their VR experiences, specifically, with whom. To note, the current study did ask participants who they use VR and/or meditate with and how often.

Beyond meditation in VR, other VR formats have been found to promote mindfulness such as those used by Kosa and Uysal (2019), who argued that VR games may be the intersection of technology and mindfulness, in that VR provides full immersion and moment-to-moment presence. VR also excels at canceling out noise distractions and indeed, Gackenbach and Bown (2011) found mindfulness was directly related to the frequency and duration of game play. Other research has also optimistically concluded that video games and VR technology are a great way to promote one's overall mindfulness (see Sliwinski et al., 2015; Choo & May, 2014). VR may be especially appealing to people who may not enjoy meditating but have specific personality traits that draw them to VR, such as mental imagination, immersive tendencies, openness, and empathy, all of which are associated with more enjoyable VR experiences and feelings of presence when using VR (Kober & Neuper, 2013; Shin, 2018).

While there is some research connecting VR and mindfulness, most of that research has focused on mindfulness meditation practices and this study aims to add to the literature by examining general VR use and mindfulness separately from meditation and mindfulness. Furthermore, this study will more broadly examine the associations between VR use, one's mindfulness, personality dispositions such as having high immersive tendency, and traits such as openness, empathy, and agreeableness to determine if specific personality types may be associated or influence one's VR use and disposition to having the socio-cognitive ability of

mindfulness (as per Langerian mindfulness definitions). The next section focuses on the traits of interest for the current research.

1.6 Connections between Personality Traits, VR, and Mindfulness

Empathy

VR also provides people the opportunity to take other's perspectives, by allowing them to step into someone else's shoes through a perceptual illusion psychologists refer to as embodiment (also referred to as the body ownership illusion). Some researchers have suggested VR is a promising tool to teach empathy-related abilities (Bertrand et al., 2018). However, other research has focused on individuals who play violent games in VR and found a decrease in empathy and prosocial behaviour as time and engagement in these violent games increases (Anderson et al., 2010). Thus, this research is interested in examining VR use and trait empathy as well.

Empathy has also been examined in relation to one's mindfulness. While the research is sparser and tends to focus on meditative mindfulness (Birnie et al., 2010; Dekeyser et al., 2008), Trent and colleagues (2015) thoroughly examined trait socio-cognitive mindfulness in relation to trait empathy and found a positive correlation between the two, concluding that perhaps the ability to notice contextual and social changes in the present moment is required for cognitive empathy. This study will try to replicate Trent and colleagues (2015) findings.

Big Five Inventory

Popular in social psychology research, the Big Five Inventory (BFI) of personality traits have been extensively assessed in a variety of research contexts and utilizing samples worldwide to support that in general, five overarching dimensions (i.e., openness, conscientiousness, extraversion, agreeableness, and neuroticism) can distinguish one's personality, temperament,

and psyche (Goldberg, 1993). Regarding Big Five traits, research has demonstrated a positive correlation between trait openness and meditation practice, and a negative correlation between neuroticism and meditation (Baer et al. 2004, 2006; Brown & Ryan 2003; Hurk et al., 2011). This study intends to replicate these findings and explore the following variables' relationship to openness (and other Big 5 variables as secondary analyses): empathy, immersive tendencies, and Langerian mindfulness. VR may foster openness (i.e., a trait denoted by interest in new experiences, active imagination, and receptiveness to new ideas), a key component of Langerian mindfulness, as VR provides opportunities for novel experiences in immersive virtual environments. This idea is supported by Jarman et al., (2016) who stated that mindfulness is related to one's openness to experience, as mindful people deconstruct their habitual mental schemas and automatic thinking by focusing on each minute detail of the present moment and priming themselves to think in novel ways.

Immersive Tendencies

Immersive tendencies was first defined by Witmer and Singer in 1998 to explain one's proclivity to become immersed in augmented reality, such as virtual environments and VR. Key features of immersive tendency are having high involvement, focus, and propensity to enjoy virtual games, all of which have been found to be highly related to presence, or the cognition of truly *being* in the augmented environment (Jerome & Witmer, 2002). Trait openness is positively associated with immersive tendencies, a psychological state characterized by the perception of being or feeling enveloped by, included in, or interacting with an environment offering continuous various stimulatory experiences (Witmer & Singer, 1998; Weibel et al., 2010). A person high in immersive tendencies may become involved in different tasks and situations, shows a tendency to maintain focus on current activities, and generally likes playing video

games, all of which relate to VR, trait openness, and Langer's concept of mindfulness (i.e., novel experiences, present awareness, engagement).

Well-being

Proponents of Langerian mindfulness have vouched for the benefits mindfulness has on reducing one's anxiety (Pagnini et al, 2018; Pagnini et al., 2016; Nadeem & Koschmann, 2021). Mindfulness allows for the acknowledgment of the uncertainty of one's position and one's being, as some philosophers suggest, one's position is inextricably tied to one's mode of being (Ha'iri Yazdi, 1992). When one is more mindful, they are not merely a passive observer of the world, instead, people can mindfully infer the context in which they are in and how contextual variables may contribute to one's perception, discomfort, distress, and connectedness with the world and others (Teo, 2005; Fatemi, 2016). In fact, decades ago, Langer and colleagues (1975) first examined how mindfulness can decrease anxiety symptoms and they found that mindfulness-inducing interventions for beneficial for building skills such as calming self-talk, cognitive reappraisals of anxiety-producing events, and enhanced cognitive control through selective attention. Further, Butt et al., (2022) recently found that active and immersive distractions (e.g., virtual reality) were more effective than passive distractions (e.g., drawing books) at lowering anxiety levels in adolescents in hospital emergency departments. Thus, combining mindfulness and VR for anxiety reduction is theoretically sane insofar that people can be in the present moment in these awe-inducing environments, while being engrossed in an activity that detracts from the anxious thoughts, without losing mind-body presence or sense of time.

Most studies have investigated general well-being as an outcome of mindfulness and this study will investigate general life satisfaction as well as eudaimonic well-being. Eudaimonic well-being more specifically assesses one's positive psychological functioning and quality of life

derived from a person fulfilling self-concordant goals (Waterman et al., 2010). Some studies have already confirmed a positive relationship between mindfulness and eudaimonic well-being (see, Jarukasemthawee & Pisitsungkagarn, 2021) however, studies using a Langerian context are lacking. Furthermore, VR allows individuals to be personally expressive in an array of environments and VR users have reported self-reflecting and personal change as a result of using VR (see Riva et al., 2016). Langerian mindfulness examines people's level of novelty-seeking and producing abilities as well as their level of engagement in day-to-day life and eudaimonic well-being examines one's level of involvement in activities and finding life to be personally expressive and meaningful. Thus, this research is interested in investigating how mindfulness and VR separately and cumulatively relate to one's eudaimonic well-being.

1.7 The Current Study

Langerian mindfulness is conceptualized as actively noticing and engaging with one's emotions and reactions to everyday events with an open, nonjudgmental mind (Langer, 2009) and is associated with many positive outcomes such as healthy interpersonal relationships, stress reduction, performance engagement, and increased well-being. While VR technology provides a present, immersive environment whilst removing distractions, few researchers have connected mindfulness to VR use (Seabrook, 2020). Moreover, the research that has evaluated VR as a tool for increasing mindfulness has not used a Langerian framework and has nearly exclusively assessed VR meditative applications for general psychological well-being. Thus, this cross-sectional correlational survey study explored associations between one's general VR use and their personality (e.g., openness and other Big Five characteristics, empathy, immersive tendencies), as well as their overall well-being (posttraumatic stress disorder (PTSD) symptomatology, anxiety, life satisfaction, and eudaimonic well-being) to determine if

associations between one's personality and VR use may predict their overall mindfulness and in turn, their well-being. Furthermore, this study asked participants about meditation use as well to compare associations between mindfulness and well-being across meditators, VR users, and those who do both.

Research Question

Are virtual reality experiences (VRE) related to immersive tendencies, openness, mindfulness, and empathy and if so, is this in turn related to well-being (life satisfaction, eudaimonic well-being)?

Hypotheses

The research question and hypotheses for this study were all pre-registered through the Open Science Framework (osf.io) and can be found here: https://osf.io/xpg3c/

I. Positive correlations between (a) VRE frequency/duration and (b) trait openness, empathy, and immersive tendencies.

II. Negative correlations between posttraumatic stress disorder symptomatology and VRE frequency/duration.

III. The frequency(a) and duration (b) of VRE should interact with mindfulness, increasing the association between mindfulness and eudaimonic well-being.

Chapter 2: Methods

This study was an online cross-sectional survey asking participants questions concerning their virtual reality and/or meditation experiences, their extent of social connection, questions assessing personality traits, and various aspects of their well-being. Participants were recruited using Prolific (www.prolific.co) and took approximately 30 minutes to complete.

2.1 Participants

A Priori Power Analysis. A power analysis was conducted with G*Power 3.1 (Faul, Lang, & Buchner, 2007) to determine how many participants would be needed to have a minimum of 80% power to detect an effect size of f^2 ~ 0.02, usually regarded as a small effect size (decided on based on previous literature; See Kohut & Campbell, 2021). This power analysis can be seen in Appendix O and was conducted based on hypothesis III (see above) because this was the main confirmatory hypothesis tested in this research. Based on this analysis, a minimum of 550 cases with complete data would be required and we decided to recruit an additional ≈110 participants to provide a 20% buffer for incomplete or untrustworthy responses. Consequently, the target recruitment N for this study was a minimum of 660 participants.

The initial number of participants recruited was 660, but six were removed for incomplete data (explained further in Chapter 3: Results). The total number of participants in this study was 654 (49.8% male). Participants resided in the United Kingdom (85%), the USA (6%), and Canada (9%). Participants ranged in age from 19 to 72 (M = 36.1, SD = 11.9). Most participants identified as White (83%), followed by South Asian (5.4%), East/Southeast Asian (4%), Black (2.3%), and Biracial/Multiracial (2.3%). Most participants had a college or undergraduate degree (54.1%), or a graduate degree (26.3%). 17.9% had a high school education or less. 90.8% (594) participants have used VR in the past year and 78.7% (515) have meditated

in the past year.

2.2 Measures

***Demographics*.** Participants were asked about their country of residence, gender identity, race/ethnicity, annual income, education level, as well as their household members (and their relationship to them, e.g., mother, brother, roommate, etc; Appendix A). Participants were also asked if they have used VR and/or meditated in the past year. If participants responded that they have done either or both, they were asked follow-up questions regarding their experiences meditating and/or using VR (see below).

Virtual Reality and Meditation Experiences. Two surveys were used to evaluate mediative and/or VR experiences (see Appendices B and C). If participants selected that they have meditated and/or used VR in the past year, follow-up questions about their experiences were presented. First, questions regarding descriptive information such as frequency and duration of VR use/meditation practice, and whether their experiences are alone or with others (and if so, with whom), and then questions regarding their feelings of social connection, self-expansion, and quality of their experiences (e.g., presence, novelty, engrossment, and enjoyment) during their VR and/or meditative experiences. These questions were assessed using a 7-point Likert scale ranging from (1) strongly disagree to (7) strongly agree or (1) not at all to (7) very much, and an average score was computed for VR and meditation experiences separately. A sample item for a social connection item is “I enjoy the social interaction with VR” for the VR version and “I enjoy the social interaction when meditating” for the meditation version; a sample item assessing the quality of one’s experience(s) is “How exciting are your VR experiences?”/”How exciting are your meditation experiences?”. The reliability of each subscale was as follows: VR Self-Expansion $\boldsymbol{\alpha}$ = .91, VR Novelty $\boldsymbol{\alpha}$ = .90, VR Presence $\boldsymbol{\alpha}$ = .79, VR

Engrossment α = .81, VR Social Connection α = .78, Meditation Self-Expansion α = .91, Meditation Novelty α = .88, Meditation Presence α = .84, Meditation Engrossment α = .83, and Meditation Social Connection α = .74. The enjoyment subscale consisted of one item, "I enjoy VR / I enjoy meditating" depending on questionnaire version.

Big Five Inventory. The Big Five Inventory (BFI), created by (John & Srivastava, 1999), is a 44-item multidimensional personality inventory (see Appendix D). Items are rated on a 5-point Likert scale ranging from (1) Strongly Disagree to (5) Strongly Agree. A sample item for each dimension is as follows: openness (10-items) "Is original, comes up with new ideas", conscientiousness (9-items) "Does things efficiently", extraversion (8-items) "Generates a lot of enthusiasm", agreeableness (9-items) "Is considerate and kind to almost everyone", and neuroticism (8-items) "Can be moody". Reliability analyses were conducted for each subscale, and all demonstrated good reliability: agreeableness α = .79, extraversion α = .87, conscientiousness α = .86, neuroticism α = .88, and openness α = .80.

Langerian Mindfulness. The 14-item Langer Mindfulness Scale (2004; LMS) assesses three domains of mindful thinking: (a) novelty seeking behaviours (5-items), "I like to investigate things", (b) novelty producing behaviours (5-items), "I find it easy to create new and effective ideas", and (c) engagement (4-items), "I avoid thought-provoking conversations (reverse-coded)". The items are scored on a 7-point Likert scale ranging from (1) strongly disagree to (7) strongly agree (see Appendix E). Item scores are summed to produce an overall score, ranging from 14-98, and higher scores represent higher mindfulness. The reliability scores for each subscale are as follows: novelty seeking α = .85, novelty producing α = .74, and engagement α =.71. The LMS scale as a whole had an alpha of α = .83.

Empathy. Trait empathy was measured using the Toronto Empathy Questionnaire (see Appendix F) created by Spreng et al., (2009). There are 16-items rated on a 5-point Likert scale which ranges from (0) rarely to (4) always, and items were summed. A sample item is "I get a strong urge to help when I see someone who is upset". Half the items are reverse-coded, an example reverse-coded item is "Other people's misfortunes do not disturb me a great deal". This scale also demonstrated high reliability, $\boldsymbol{\alpha}$ =.89.

Immersive Tendencies. Witmer and Singer (1998) proposed that immersive tendency is a disposition to become immersed in virtual environments, i.e., someone who easily experiences "presence". The immersive tendencies questionnaire used for this study (see Appendix G) was the 18-item revised version developed by the Cyberpsychology Laboratory in Quebec (2004). Participants answered questions using a 7-point Likert scale ranging from (1) never to (7) often. Items were summed and analyzed as a single scale as the original authors recommended. Questions 3, 7, 8, and 13 use slight wording variations in the scale end points unique to their question wording (see Witmer & Singer, 1998 for exact scale-wording variations). Overall, this scale demonstrated high reliability, $\boldsymbol{\alpha}$ = .82.

Eudaimonic Well-being. Eudaimonic well-being was measured using Waterman and colleagues (2010) questionnaire for eudaimonic well-being which contains 21-items answered on a 5-point Likert scale ranging from (0) strongly disagree to (4) strongly agree. A sample item includes, "I believe I have discovered who I really am" and a sample reverse-coded item is "As of yet, I've not figured out what to do with my life". This scale assesses feelings of self-discovery, development of one's best potentials, sense of intrinsic purpose and meaning, and intense engagement with activities. The Cronbach's alpha for this scale was $\boldsymbol{\alpha}$ = .84 (See Appendix H for the scale).

PTSD. The PTSD Checklist-Civilian (PCL-C; Weathers et al., 1993) was used to assess presence (and if so, severity) of PTSD symptoms over the past month (see Appendix I). This questionnaire has 17-items which are measured using a 5-point Likert scale ranging from (0) not at all, to (4) extremely. Item scores are aggregated to create an overall mean score. This scale has demonstrated validity and reliability for use in the general population. For example, one item asks in the past month how often the participant was bothered by "Feeling very upset when something reminded you of a stressful experience from the past?". The PCL-C has a high alpha of $\boldsymbol{\alpha}$ = .94 for the current study.

Satisfaction with Life. The Satisfaction with Life Scale (Diener, Emmons, Larson, & Griffin, 1985) consists of five global statements that allow participants to evaluate their lives according to their own internalized perceptions of life satisfaction (see Appendix J). Participants rated each statement on a 7-point Likert Scale where they indicated their level of agreement with each item from (1) strongly disagree to (7) strongly agree. Example questions include: "The conditions of my life are excellent", and "In most ways my life is close to my ideal" and items were averaged for an overall score. Research has demonstrated that this scale shows strong internal validity and moderate temporal validity (Pavot & Diener, 1993). The cronbach's alpha is high α = .87, and the test-retest coefficient two months later is α = .82. Pavot and Diener (1993) also concluded that this scale demonstrates adequate convergent validity as it correlates well with other measures of well-being and negatively correlates with measures of depression and anxiety. For this study, the cronbach's alpha was also high, $\boldsymbol{\alpha}$ = .91.

Anxiety. Trait anxiety was assessed using 5-items from the State-Trait Anxiety Inventory - Trait (STAIT-5) (Zsido et al., 2020). These items ask participants about "how they generally feel" using a 4-point Likert scale ranging from (0) not at all, to (3) very much so (see

Appendix K). A sample item is “Some unimportant thoughts run through my mind and bothers me”. This scale also demonstrated high reliability, $\boldsymbol{\alpha}$ = .89.

2.3 Procedure

The design of this study was a cross-sectional self-report survey and participants were recruited online through Prolific (www.prolific.co), where a link to the study to the Western Qualtrics survey platform was available for eligible participants. Participation was entirely voluntary, and the study took approximately 30 minutes to complete. Participants could skip any question(s) after the consent and captcha. Upon clicking the survey link, participants were presented with the letter of information and indicated their consent by clicking an “agree to participate” button at the bottom of the screen.

The demographic questionnaire was presented first, then the VR and meditation experiences questionnaires. Next, participants completed the following scales in the presented order: Satisfaction with Life (Diener et al., 1985), Langer Mindfulness Scale (Langer et al., 2004), Immersive Tendencies Questionnaire (Witmer & Singer, 1998), Virtual Reality and Meditative Experiences (based on Kohut & Campbell, 2021), The Big-Five Inventory (John & Srivastava, 1999), Eudaimonic Well-being (Waterman et al., 2020), Toronto Empathy Questionnaire (Spreng et al., 2009), the trait anxiety subscale from the State-Trait Anxiety Inventory (Zsido et al., 2020), and finally the PTSD Checklist - Civilian Version.

Participants were then provided with a debriefing letter containing relevant research literature, the study goals and hypotheses, contact information, and resources for participants who could have experienced distress from completing the study. Their Prolific compensation code appeared at the bottom of the debriefing form page, which participants were instructed to paste into the Prolific website for their $4.00 payment

Chapter 3: Results

3.1 Data Screening

Steps were first taken to prepare the raw data for analysis. Immediately after downloading the data from Qualtrics, identifiable details were removed including participant IP addresses, automatically generated response IDs, latitude and longitudes, and survey IDs. In total, 660 responses were collected, and five participants did not complete either one of the VR or meditation questionnaires or withdrew early in the study and therefore were removed. Participant data was also to be removed if they failed both attention checks in the survey, however, all participants answered both attention checks correctly. Of the remaining 655 participants, the following criteria were used to manage missing data and assess data quality and completeness:

Case-mean substitution was used for participants who had missing data if their data met the following criteria: (1) fewer than 60% of items on a given measure for a participant are missing, (2) fewer than 15% of cases for a given measure of missing (based on Fox-Wasylyshyn & El-Masri, 2015). One participant was removed for having less than 50% of the personality and well-being measures completed (e.g., satisfaction with life, big five inventory, and eudaimonic well-being), therefore the final sample size was 654 participants.

3.2 Descriptive Data

First, descriptive statistics were computed to determine frequency distributions of VR and meditation use (see Table 1 and Table 2), as well as assess the basic demographic information (see *2.1 Participants*). As presented in Table 1, in the past year, more participants have meditated alone (n = 491) or with someone they met online (n = 118) than having used VR alone (n = 330) or with someone they met online (n = 36). Interesting, more participants have used VR with friends (n = 242), family (n = 202), and their romantic partner(s) (n = 134) than those who have mediated with their friends (n = 74), family (n = 53), or romantic partner(s) (n = 83). For both meditators and VR users, most experiences were alone. Regarding the duration of experiences, most participants indicated that they meditate and/or use VR for short durations, usually under 15 minutes a session.

Table 1. VR and Meditation Frequency of Experiences Descriptive Information

(N)		Almost Never	<1x Month	1-3x Month	1-2x Week	3-4x Week	Daily	*Total*
Alone	VR	98	91	57	57	23	4	*330*
	MED	54	87	133	96	73	48	*491*
	Total	*152*	*178*	*190*	*153*	*96*	*52*	
Someone Online	VR	9	7	10	10	0	0	*36*
	MED	40	19	21	24	10	4	*118*
	Total	*49*	*26*	*31*	*34*	*10*	*4*	
Friend	VR	96	87	48	10	1	0	*242*
	MED	34	24	7	6	3	0	*74*
	Total	*130*	*111*	*55*	*16*	*4*	*0*	
Family	VR	72	69	39	18	4	0	*202*
	MED	20	10	7	13	3	0	*53*
	Total	*92*	*79*	*46*	*31*	*7*	*0*	
Partner	VR	52	37	29	15	1	0	*134*
	MED	33	16	15	12	6	1	*83*
	Total	*85*	*53*	*44*	*27*	*7*	*1*	

Note: MED = meditation

Table 2 VR and Meditation Duration of Experiences Descriptive Information

(N)		<15mins	15-30 mins	30-60 mins	1-2 hours	3-4 hours	>5 hours
Alone	VR	202	39	34	68	15	4
	MED	173	146	70	63	18	9
	Total	*375*	*185*	*104*	*131*	*33*	*13*
Someone Online	VR	11	4	9	11	1	0
	MED	40	27	18	10	2	0
	Total	*51*	*31*	*27*	*21*	*3*	*0*
Friend	VR	153	26	34	27	4	1
	MED	32	15	4	2	0	0
	Total	*185*	*41*	*38*	*29*	*4*	*1*
Family	VR	129	32	25	20	1	1
	MED	21	9	4	2	1	0
	Total	*150*	*41*	*29*	*22*	*2*	*1*
Partner	VR	75	25	21	16	0	2
	MED	35	17	6	7	1	0
	Total	*110*	*42*	*27*	*23*	*1*	*2*

3.3 Correlational Analyses

To test the first hypothesis that increased VR use and/or meditation practice would be positively associated with the personality variables, correlations were calculated amongst the VR variables and openness, immersive tendencies, empathy, and mindfulness. The frequency and duration of VR use were significantly correlated as anticipated, $r = .88$, $p < .001$, however, the frequency and/or duration of VR use was not significantly correlated to any of the personality variables (i.e., empathy, extraversion, any of the big five measures, mindfulness). The questions regarding an individual's subjective VR experiences (e.g., feelings of presence, novelty, engrossment, socialization, enjoyment, and self-expansion) were related to many of the outcome variables (See Table 3). Specifically, openness was positively correlated with all the VR

subscales and immersive tendencies was also positively correlated with all the VR subscales.

Table 3. Correlations Among VR Subjective Responses and Personality Variables

	1	2	3	4	5	6	7	8	9	10
1.VR Self-Expansion	1									
2.VR Novelty	.52**	1								
3.VR Presence	.57**	.36**	1							
4.VR Engrossment	.46**	.43**	.32**	1						
5.VR Social	.37**	.43**	.57**	.30**	1					
6.VR Enjoyment	.50**	.75**	.43**	.44**	.48**	1				
7.Empathy	.04	.19**	.05	.08	.13*	.13*	1			
8.Immersive Tendencies	.25**	.17**	.19**	.33**	.24**	.18**	.23**	1		
9.Openness	.17**	.16**	.11*	.10*	.16**	.11*	.31**	.22**	1	
10.Mindfulness	.12*	.16**	.10*	.07	.15**	.12*	.36**	.20**	.73**	1
Mean	3.64	5.46	6.87	4.12	4.55	5.46	62.64	76.95	3.57	72.71
SD	1.41	1.07	2.91	1.00	1.15	1.22	8.69	14.40	0.64	9.89

Note: ** p<.001, * p<.05

Next, presented in Table 4 are the correlations between the meditation variables and the personality variables (i.e., empathy, immersive tendencies, openness, and mindfulness). The frequency and duration of mediation practice were significantly intercorrelated as well, also as anticipated, $r = .93$ $p < .001$, and were also significantly associated with the personality variables hypothesized: openness ($r = .13$, $p < .001$, and $r = .17$, $p < .001$, respectively), mindfulness ($r = .08$, $p < .05$, and $r = .11$, $p < .01$, respectively), and empathy ($r = .11$, $p < .01$, and $r = .12$, $p < .01$, respectively).

Table 4. Correlations Among MED Subjective Responses and Personality Variables

	1	2	3	4	5	6	7	8	9	10
1.MED Self-Expansion	1									
2.MED Novelty	.73**	1								
3.MED Presence	.35**	.32**	1							
4.MED Engrossment	.58**	.60**	.21**	1						
5.MED Social	.29**	.29**	.58**	.18**	1					
6.MED Enjoyment	.65**	.71**	.22**	.66**	.22**	1				
7.Empathy	.25**	.21**	-.09	.16**	.05	.23**	1			
8.Immersive Tendencies	.23**	.15**	.10*	.30**	.06	.14*	.23**	1		
9.Openness	.25**	.23**	.02	.19**	.09*	.18**	.31**	.22**	1	
10.Mindfulness	.19**	.14*	-.09*	.13*	.01	.14*	.36**	.20**	.73**	1
Mean	4.07	4.19	4.15	4.55	2.87	5.27	62.64	76.95	3.57	72.71
SD	1.39	1.33	2.61	1.04	1.20	1.35	8.69	14.40	0.64	9.89

Note: ** p<.001, * p<.05

For the second hypothesis, we predicted that increased VR and/or meditation use would be related to positive well-being outcomes (i.e., satisfaction with life and eudaimonic well-being)

and negatively to PTSD and anxiety symptoms. However, neither VR frequency and duration nor meditation frequency and duration were not related to any of the well-being outcome variables (i.e., eudaimonic well-being, PTSD symptomology, and anxiety) (see Table 5).

Table 5. Correlations Among Well-being variables and VR/MED

	1	2	3	4	5	6	7	8
1. PTSD	1							
2. Anxiety	.70**	1						
3. Eudaimonic Well-Being	-.38**	-.47**	1					
4. Satisfaction with Life	-.40**	-.35**	.47**	1				
5. VR Frequency	-.03	-.11*	.05	.02	1			
6. VR Duration	-.03	-.07	.01	-.02	.88**	1		
7. MED Frequency	.10*	.02	.08*	.03	.09*	.08	1	
8. MED Duration	.09*	.04	.09*	.03	.10*	.03*	.93**	1
Mean	36.21	11.31	73.73	4.26	4.65	2.91	7.59	6.17
SD	14.51	4.02	10.54	1.39	4.16	3.18	5.03	3.95

Note: ** p<.01, * p<.05

3.4 Regression Analyses

To test the third hypothesis that the frequency(a) and duration (b) of VR use should interact with mindfulness, increasing the association between mindfulness and eudaimonic well-being as frequency and/or duration of use increased, we first created mean-centered independent variables for mindfulness, VR frequency and duration. Then a regression analysis first with VR frequency and mindfulness as predictors of EWB was conducted and the model was significant, $R^2 = .22$, $F(2, 651) = 90.33$, $p < .001$, however, only mindfulness was a significant (albeit weak) predictor, $\beta = .04$, $p < .001$. To assess the assumption of independence, separate scatterplots of the residuals of VR frequency and mindfulness variables were created and displayed random

distribution of points without any sort of pattern, thus the independence assumption was satisfied (Hahs-Vaughn & Lomax, 2020, pp. 878–879). The scatterplot of standardized residuals demonstrated that the data met the assumptions of homogeneity of variance and linearity (Hahs-Vaughn & Lomax, 2020, pp. 879–884). Tests to determine if the data met the assumption of collinearity indicated that multicollinearity was not a concern as the variance inflation factor (VIF) was close to 1 (VR Frequency, Tolerance = .99, VIF = 1.01; mindfulness, Tolerance = .99, VIF = 1.01). Cook's distance was also near-zero.

Finally, an interaction term between VR frequency and mindfulness was created and added to the regression as a third predictor of EWB, but was not significant, demonstrating that VR frequency does not predict one's EWB and does not interact with mindfulness.

In a second model, VR duration and mindfulness were entered as predictors of EWB and in this model (R^2 = .22, $F(2, 651) = 90.34$, $p < .001$), only mindfulness was a significant predictor, $\beta = .04$, $p < .001$. An interaction term between VR duration and mindfulness was created and added to the regression as a third predictor of EWB. This interaction term was also not significant.

3.5 Exploratory Analyses

Exploratory analyses focused on mindfulness and meditation frequency. Mindfulness and meditation frequency were separately tested as predictors of EWB again only mindfulness was a significant predictor, $\beta = .36$, $p < .001$. Mindfulness and meditation duration were entered as predictors of EWB and only meditation duration was a significant predictor, $\beta = .16$, $p < .001$. An interaction term between meditation frequency and mindfulness, as well as duration, was created and added to the regression models, but was not significant in either model, demonstrating that VR frequency does not predict one's EWB and does not interact with mindfulness.

To test if one's personality traits (specifically empathy, immersive tendency, and big five variables) predicted VR enjoyment, first, a correlation matrix was constructed between all variables to determine which variables to include as predictors in the subsequent regression model. Empathy $r = .13$, $p < .01$, agreeableness, $r = .12$, $p < .01$, openness, $r = .11$, $p < .001$, and immersive tendencies, $r = .18$, $p < .001$ were significantly associated with VR enjoyment. Then, a regression model was run with empathy, openness, agreeableness, and immersive tendencies as the predictors and VR enjoyment as the outcome variable. Only immersive tendencies was a significant predictor, however, the beta coefficient was very small, $\beta = .01$, $p < .001$.

The same correlation matrix was constructed but with meditation enjoyment instead of VR enjoyment and all variables were significantly associated with each other, (see Table 6). A regression model was run with meditation enjoyment as the dependent variable and block 1 predictors were the big five variables, of which, extraversion ($\beta = .20$, $p < .01$), agreeableness ($\beta = .28$, $p < .01$), and openness ($\beta = .24$, $p < .01$) were significant predictors. However, when immersive tendencies and empathy were added in as block 2 predictors, only empathy and immersive tendencies were significant, but the beta coefficients were also very small: empathy ($\beta = .02$, $p < .001$), and immersive tendencies ($\beta = .01$, $p < .001$).

Chapter 4: Discussion

4.1 Discussion

The present study examined associations between mindfulness and VR, and how personality traits such as openness, immersive tendencies, and empathy are related to one's mindfulness and/or virtual reality experiences. Participants were given online surveys that used Likert-style scales that asked about their VR and/or meditation experiences as well as a variety of surveys asking about their personality and overall well-being. Consistent with O'Connor and

colleagues' scoping review (2022), this study found little evidence of virtual reality as a beneficial mindfulness tool for well-being.

The first hypothesis for this study was that increased VR use (i.e., frequency and duration) would be positively correlated to immersive tendencies, empathy, and openness. Interestingly, the frequency and duration of VR use were not associated with these personality traits, however, the openness and immersive tendencies variables were positively associated with the VR subjective experiences subscales, which specifically assessed feelings of self-expansion, engrossment, novelty, social, presence, and enjoyment while using VR.

Empathy was positively associated with social, novelty, and enjoyment subscales, but had near zero associations with the other subscales (i.e., self-expansion, engrossment, and presence). The Toronto Empathy Questionnaire (Spreng et al., 2009) measures one's emotional processing ability to understand and respond to others (i.e., perspective take), but does not assess one's feelings and experiences, which may partially explain why empathy was related to the social but not the self-expansion measure. Further, empathy may be positively associated with the presence subscale but not the engrossment subscale because the presence items more precisely measured one's feelings of being socially present with others (i.e., transported into the VR world with other people and engaging with them; Biocca, Harms, & Gregg, 2001), but the engrossment items measure one's duration inside the VR world and ability to lose a sense of time due to high immersion, not assessing perspective shifting as the presence subscale items did. Weech, Kenny, and Barnett-Cowan (2019) argued how VR users may feel highly engrossed in these immersive environments, but not necessarily feel presence, as engrossment demonstrates high attentiveness to the VR task, but not necessarily feeling moment-to-moment awareness. In fact, many VR users feel they lose a sense of time when highly engrossed in a VR task (Barfield 1995).

The second hypothesis indicated that VR experiences would be negatively associated with PTSD and anxiety symptomology and the results from this study did not find any significant evidence for this hypothesis. This finding is partially inconsistent with past research indicating VR may be a great tool to alleviate PTSD symptomology and with an array of VR formats from exposure therapy combat games for war veterans to relaxing mindfulness nature scenes (Deng et al., 2019; Rizzo & Shilling, 2017). However, this study assessed if general VR use was related negatively to PTSD symptomology and did not specifically assess applications meant to alleviate PTSD symptoms as an exposure therapy approach would. Recently, Björling et al., (2022) evaluated general VR use and well-being by assessing the effect of nature-based VR environments on adolescents' mental health. They found that VR was a successful tool for reducing stress and concluded that VR appears to be a promising tool, especially for adolescents. Unfortunately, this study does not add to the literature that general VR use is associated with anxiety or PTSD reduction and had near-zero correlations with eudaimonic well-being and satisfaction with life. This was true regarding the frequency and duration of VR use as well as the subjective experiences subscales (e.g., enjoyment, self-expansion, presence, engrossment, novelty). If this study had assessed VR use specifically for PTSD reduction, the results may have been clearer, but this study only assessed general VR use, thus there is no distinction between people who use VR for enjoyment or distractions or to improve themselves (e.g., social skills, relaxation, to improve their well-being).

Perhaps VR is used more for social connection (Kohut & Campbell, 2021) as well as entertainment, therefore, the excitement and intensity that VR offers does not allow users to embrace the calming and relaxing effects of mindfully being engaged. Indeed, some research has found that VR experiences can evoke acute stress reactions which activate the sympathetic

nervous system, which produces the opposite of a calming effect (Fadeev et al., 2020). However, it is important to note that Fadeev et al., (2020) tested this in what they entitled “extreme” stress scenarios (e.g., roller coasters, space station exploration), and for the current study it is not known if participants engaged in similar VR activities (e.g., scary games, endurance activities) opposed to more relaxation activities (e.g., meditating, nature walks). Future research should distinguish the type of VR activity to determine if mindfulness may be associated with these relaxing activities as opposed to other general use like gaming and working out.

Finally, through our exploratory analyses, some interesting results were unveiled. First, while openness was the primary variable of interest from the big five inventory, agreeableness yielded interesting results as well. First, our findings were consistent with Trent and colleagues’ (2017) research that found a strong correlation between empathy and agreeableness, and this is consistent with other literature on personality traits and empathetic capacity in a variety of settings, such as in hospitals, senior centres, etc. (Song & Shi, 2017; Mooradian & Matzler, 2011). This is theoretically sound as well as empathetic concern is a feature of agreeableness (Thompson & Waltz, 2007). Openness may be related to mindfulness insofar that mindful people may be more receptive to active experiences and appreciate novelty (Tan et al., 2021). Agreeableness may also be related to mindfulness as Langerian mindfulness states that perspective-taking and being socially engaged are necessary for mindful living (Langer, 1989). Additionally, Van Doesum and colleagues (2013) proposed a connection between agreeableness and Langerian mindfulness, specifically social mindfulness, and, like this study, found a positive association between agreeableness and Langerian mindfulness. This current study also found positive associations between both openness and agreeableness, and mindfulness, which is consistent with other research and theory (Giluk, 2009; Thompson & Waltz, 2007).

4.2 Limitations

The current analyses explored associations between one's personality, virtual reality experiences, and well-being. Despite some of the interesting findings, there are limitations to this study that must be taken into consideration. While we could pre-screen for an evenly split male/female sample, there was still an uneven distribution of sample characteristics such as the sample being predominantly white, English speaking, and had obtained some form of postsecondary education. Also, nearly 85% of the sample came from the United Kingdom and a minority came from the USA or Canada. While Prolific is a great website for quickly obtaining data that is still comparable to lab studies (Peer et al., 2017), these recruitment websites tend to have a bias towards women and individuals with high(er) levels of education (i.e., WEIRD bias). WEIRD samples tend to be biased towards Western, educated, industrialized, rich, and democratic individuals, therefore the sample is not truly representative of the general population (Heinrich, Heine, & Norenzayan, 2010). Therefore, research in other countries and utilizing more diverse samples is necessary to draw conclusions about the associations between virtual reality, mindfulness, and personality.

Another limitation of the current study is that we did not ask participants to specify what VR activities they engaged in or what specific applications were used. Kelly et al., (2022) created a framework to help researchers design VR applications to improve mindfulness and theorized that five components are necessary to inform the VR design process: setting (i.e., social context, environment), hardware (i.e., type of technology), activity (i.e., what type of mindfulness practice, method of delivery, and focus points), content (i.e., meditation guide, virtual content), and interaction (i.e., user interface within the virtual environment). Each component may be influential on another component, for example, deciding to do a mindfulness

meditation practice could influence the type of relaxing audio, level of interaction, and virtual environment in that the meditation takes place. Thus, with this framework, applications designed to promote mindfulness with these components would be more likely to promote mindfulness and mindful change in the users. Future research should always specify what VR applications participants are using, especially differentiating between calming versus stimulating activities to provide data clarity.

4.3 Implications

More recently, the benefits of mindfulness have been extensively researched and advertised to the public through the exponential increase in mindfulness applications and games, including virtual reality applications. In fact, on PsycInfo the term mindfulness was used approximately 1700 times in the first decade of the 2000s but in the 2010s the term was used over 12,300 times. Mindfulness has already appeared in over 4,700 articles on this database alone since the start of the 2020s. Some of this research is beginning to depart from pairing mindfulness and meditation together, and instead, focus on other applications and tools to improve one's mindfulness such as using VR environments for relaxation training (Chandrasiri et al., 2019). This has become of more interest to researchers, as meditation is not an all-encompassing nor mutually enjoyable mindfulness activity. Multiple researchers have documented the risk factors of having adverse meditation experiences, specifically traumatic histories, which may cause the meditator to have intrusive thoughts, cognitive changes, negative affect, and hypervigilance (Cebolla et al., 2017; Lindahl et al., 2020). Therefore, validating other methods, such as virtual reality experiences, that may increase one's mindfulness is crucial to allow everyone to experience the benefits of mindfulness without having to meditate to achieve it. Unfortunately, this study did not contribute to the literature that VR is related to one's

mindfulness, but it has drawn some interesting connections between personality traits and VR enjoyment, engrossment, and sociability as well as replicated findings consistent with the literature that meditation (for those who enjoy it) is related to mindfulness, openness, and empathy.

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Appendices

Appendix A

Demographics

DEM01 In which country are you currently living?

o Canada

o United States

o Other (Please specify)

_____

DEM02 What is the gender with which you currently identify?

o Male

o Female

o Non-binary

o Transgender

o If you feel that your gender cannot be represented by one of the options above we invite you to write in how you identify in the space provided here:

_____

DEM03 What is your race or ethnicity?

o Black/African Origin

o East/Southeast Asian

o Hispanic or Latinx

o Indigenous, Native American, First Nation, Innuit, or Alaska Native

o Middle Eastern

o Native Hawaiian or Other Pacific Islander

o South Asian

o White

o Biracial/Multiracial

o If you feel that your race/ethnicity cannot be represented by one of the options above we invite you to write in how you identify in the space provided here:

_____

DEM04 What is your typical annual income?

o I do not do paid work outside the home

o Below $20,000

o $20,000 - $29,999

o $30,000 - $39,000

o $40,000 - $49,000

o $50,000 - $59,000

o $60,000 - $69,000

o $70,000 - $79,000

o $80,000 - $89,000

o $90,000 - $99,000

o $100,000 or more

o Prefer not to say

DEM05 What is the highest level of education that you have COMPLETED?

o High School or Less

o College Program or Undergraduate Degree

o Graduate (MA / MSc / PhD etc.) or Professional Degree (MD, LLB, etc.)

o If you feel that your education level cannot be represented by one of the options above we invite you to write in how you identify in the space provided here: _____

DEM06 Including yourself, how many people live in your household?

o 1 person (I live alone)

o 2 people

o 3 people

o 4 people

o 5 or more people

DEM06a Who do you live with (select all that apply)?

▢ Spouse(s) or romantic partner(s)

- ▢ Sibling(s)
- ▢ Child(ren)
- ▢ Parent(s) or parent(s)-in-law
- ▢ Other family member(s)
- ▢ Roommate(s)
- ▢ Other, please specify: _____

Appendix B

Virtual Reality Questionnaire

The following questions refer to the use of virtual reality (VR). For the purposes of this study, VR means immersive, three-dimensional, computer-generated environments that can be explored or interacted with by one or more people.

VR-Use(N/Y) Have you ever used VR?

o No

o Yes

VR01 Who have you used VR with? Select all that apply.

▢ Alone

▢ Someone you met online

▢ A friend

▢ A family member

▢ A romantic partner

▢ Other (please specify)

_____

VR02 On average, how much time do you spend in VR per week with each of these people?

	< 15 mins	15-30 mins	30-60mins	1-2 hours	3-4 hours	5+
Alone	o	o	o	o	o	o
Someone you met online	o	o	o	o	o	o
A friend	o	o	o	o	o	o
A family member	o	o	o	o	o	o
A romantic partner	o	o	o	o	o	o

VR03 On average, how often do you use VR with these people?

	Never	Almost never	<1/mnth	1-3x/mnth	1-2x/wk	3-4x/wk	Daily	1+/day
Alone	o	o	o	o	o	o	o	o
Someone you met online	o	o	o	o	o	o	o	o
A friend	o	o	o	o	o	o	o	o
A family member	o	o	o	o	o	o	o	o
A romantic partner	o	o	o	o	o	o	o	o

VR04 If you consider all of your VR experiences, what proportion of these experiences are spent using VR alone as compared to using VR with other people?

- o I only use VR alone (1)
- o ... (2)
- o ... (3)
- o 50% / 50%
- o ... (5)
- o ... (6)
- o I only use VR with others (7)

Please answer each question according to the way you have personally felt since the outbreak of COVID-19

VRC1 How much does your use of VR result in you having new experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5

- o 6
- o 7 Very much

VRC2 Do you feel a greater awareness of things because of using VR?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC3 How much does VR expand your sense of the kind of person you are?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC4 How much does VR provide you with a source of excitement?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC5 How much do you feel you have gained a larger perspective of things because of using VR?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC6 How much has using VR resulted in you learning new things?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC7 How fun are your VR experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC8 How interesting are your VR experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC9 How exciting are your VR experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC10 How boring are your VR experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC11 How dull are your VR experiences?

- o 1 Not at all
- o 2
- o 3

- o 4
- o 5
- o 6
- o 7 Very much

VRC12 There is a sense of human contact in VR.

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC13 There is a sense of sociability in VR

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

VRC14 I enjoy using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC15 I feel detached from the outside world while using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC16 I do not care to check events that are happening in the real world when using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC17 I cannot tell that I am getting tired while using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC18 Sometimes I lose track of time while using VR

- o Strongly disagree

- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC19 I temporarily forget about my everyday worries while using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC20 I tend to spend more time using VR than I have planned

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC21 I can block out most other distractions when using VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree

- o Agree
- o Strongly agree

VRC22 Whenever I stopped using VR, I could not wait to start using it again

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC23 I find that VR supports social interactions (e.g., chat) between users

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC24 I like to use VR with others

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC25 I am able to use VR with other players if I choose

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

VRC26 I enjoy the social interaction within VR

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

Appendix C

Meditation Questionnaire

The following questions refer to the practice of meditation. For the purposes of this study, meditation means the practice of "paying attention, on purpose, in the present moment and non-judgmentally. . . by focusing on the breath, the idea is to cultivate attention on the body and mind as it is moment to moment" (Kabat-Zinn, 1990).

MD01 Have you ever meditated?

o Yes

o No

MD02 How do you prefer to meditate? (Select all that apply)

▢ Alone without technology

▢ Alone with technology (e.g., mobile phone application, virtual reality, online video)

▢ With others in person

▢ With others online (e.g., in virtual reality, over a video)

MD02a Which technology/technologies do you like to use to meditate? (Please select all that apply)

▢ Virtual reality

▢ Mobile phone application

▢ Online video

▢ Other, please specify

_____

MD02b If you consider all of your meditation experiences, what proportion of these experiences are spent in virtual reality?

o None - 0%

o Some - 25%

o Half - 50%

o Most - 75%

o All - 100%

MD03 How many days has it been since you last meditated? (Please select and answer for all that apply)

Please enter a value of 0 if you meditated earlier today and leave blank if not applicable

☐ ...alone? _____

☐ ...with an online instructor? _____

☐ ...with a friend? _____

☐ ...with a family member? _____

☐ ...with a romantic partner? _____

MD04 On average, how much time do you spend meditating per week...

	< 15 mins	15-30 mins	30-60mins	1-2 hours	3-4 hours	5+
Alone	o	o	o	o	o	o
Someone you met online	o	o	o	o	o	o
A friend	o	o	o	o	o	o
A family member	o	o	o	o	o	o
A romantic partner	o	o	o	o	o	o

MD05 On average, how often do you meditate...?

	Never	Almost never	<1/mnth	1-3x/mnth	1-2x/wk	3-4x/wk	Daily	1+/day
Alone	o	o	o	o	o	o	o	o
Someone you met online	o	o	o	o	o	o	o	o

A friend	o	o	o	o	o	o	o	o
A family member	o	o	o	o	o	o	o	o
A romantic partner	o	o	o	o	o	o	o	o

MD06 If you consider all of your meditation experiences, what proportion of these experiences are spent alone as compared to meditating with other people?

- o I only meditate alone (1)
- o ... (2)
- o ... (3)
- o 50% / 50%
- o ... (5)
- o ... (6)
- o I only meditate with others (7)

MD07 Which of the following people have you meditated with (check all that apply)?

- ▢ No one; I never meditate with others
- ▢ Acquaintances
- ▢ Offline friends
- ▢ Online friends
- ▢ Parents
- ▢ Siblings
- ▢ My children
- ▢ Other family
- ▢ Romantic partner(s)
- ▢ Others (please specify)

_____

Please answer each question according to the way you have personally felt since the outbreak of COVID-19

MC01 Does your meditation practice(s) result in you having new experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC02 Do you feel a greater awareness of things because of meditating?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC03 How much does meditation expand your sense of the kind of person you are?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC04 How much does meditation provide you with a source of excitement?

- o 1 Not at all

- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC05 How much do you feel you have gained a larger perspective of things because of meditating?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC06 How much has meditating resulted in you learning new things?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC07 How fun are your meditation experiences?

- o 1 Not at all
- o 2
- o 3
- o 4

- o 5
- o 6
- o 7 Very much

MC08 How interesting are your meditation experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC09 How exciting are your meditation experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC10 How boring are your meditation experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC11 How dull are your meditation experiences?

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC12 There is a sense of human contact when meditating

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC13 There is a sense of sociability when meditating

- o 1 Not at all
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7 Very much

MC14 I enjoy meditating

- o Strongly disagree

- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC15 I feel detached from the outside world while meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC16 I do not care to check events that are happening in the real world when I meditate

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC17 I cannot tell that I am getting tired while meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree

- o Somewhat agree
- o Agree
- o Strongly agree

MC18 Sometimes I lose track of time while meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC19 I temporarily forget about my everyday worries while meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC20 I tend to spend more time meditating than I have planned

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC21 I can block out most other distractions when meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC22 Whenever I stopped meditating, I could not wait to start using it again

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC23 I find that meditation supports social interactions between users

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC24 I like to meditate with others

- o Strongly disagree
- o Disagree
- o Somewhat disagree

- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC25 I am able to meditate with others if I choose

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

MC26 I enjoy the social interaction when meditating

- o Strongly disagree
- o Disagree
- o Somewhat disagree
- o Neither agree nor disagree
- o Somewhat agree
- o Agree
- o Strongly agree

Appendix D

Big Five Inventory (John & Srivastava, 1999)

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement.

Strongly Disagree	Disagree a little	Neither agree nor disagree	Agree a little	Strongly agree
1	2	3	4	5

I see Myself as Someone Who...

____1. Is talkative
____2. Tends to find fault with others
____3. Does a thorough job
____4. Is depressed, blue
____5. Is original, comes up with new idea
____6. Is reserved
____7. Is helpful and unselfish with others
____8. Can be somewhat careless
____9. Is relaxed, handles stress well
____10. Is curious about many different
____11. Is full of energy
____12. Starts quarrels with others
____13. Is a reliable
____14. Can be tense
____15. Is ingenious, a deep thinker
____16. Generates a lot of enthusiasm
____17. Has a forgiving nature
____18. Tends to be disorganized
____19. Worries a lot
____20. Has an active imagination
____21. Tends to be quiet
____22. Is generally trusting
____23. Tends to be lazy
____24. Is emotionally stable, not easily upset
____25. Is inventive
____26. Has an assertive personality
____27. Can be cold and aloof
____28. Perseveres until the task is finished
____29. Can be moody
____30. Values artistic, aesthetic experiences
____31. Is sometimes shy, inhibited
____32. Is considerate and kind to almost everyone
____33. Does things efficiently
____34. Remains calm in tense situations
____35. Prefers work that is routine
____36. Is outgoing, sociable
____37. Is sometimes rude to others
____38. Makes plans and follows through with them
____39. Gets nervous easily
____40. Likes to reflect, play with ideas
____41. Has few artistic interests
____42. Likes to cooperate with others
____43. Is easily distracted
____44. Is sophisticated in art, music, or literature

Appendix E

Langer Mindfulness Scale (Pirson, Langer, & Zilcha, 2018)

(1=Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree nor disagree, 5 = Somewhat agree, 6=Agree, 7=Strongly agree)

1) I like to investigate things. (NS)
2) I generate few novel ideas. (NP)
3) I make many novel contributions. (NP)
4) I seldom notice what other people are up to. (E)
5) I avoid thought provoking conversations. (E)
6) I am very creative. (NP)
7) I am very curious. (NS)
8) I try to think of new ways of doing things. (NS)
9) I am rarely aware of changes. (E)
10) I like to be challenged intellectually. (NS)
11) I find it easy to create new and effective ideas. (NP)
12) I am rarely alert to new developments. (E)
13) I like to figure out how things work. (NS)
14) I am not an original thinker. (NP)

Note. NS = Novelty Seeking; NP = Novelty Producing; E = Engagement

Appendix F

Toronto Empathy Questionnaire (Spreng et al., 2009)

Below is a list of statements. Please read each statement *carefully* and rate how frequently you feel or act in the manner described. Circle your answer on the response form. There are no right or wrong answers or trick questions. Please answer each question as honestly as you can.

1. When someone else is feeling excited, I tend to get excited too
2. Other people's misfortunes do not disturb me a great deal
3. It upsets me to see someone being treated disrespectfully
4. I remain unaffected when someone close to me is happy
5. I enjoy making other people feel better
6. I have tender, concerned feelings for people less fortunate than me
7. When a friend starts to talk about his\her problems, I try to steer the conversation towards something else
8. I can tell when others are sad even when they do not say anything
9. I find that I am "in tune" with other people's moods
10. I do not feel sympathy for people who cause their own serious illnesses
11. I become irritated when someone cries
12. I am not really interested in how other people feel
13. I get a strong urge to help when I see someone who is upset
14. When I see someone being treated unfairly, I do not feel very much pity for them
15. I find it silly for people to cry out of happiness
16. When I see someone being taken advantage of, I feel kind of protective towards him\her

Appendix G

Immersive Tendencies Questionnaire (Witmer & Singer, 1998)

Indicate your preferred answer by marking the appropriate choice on the seven-point scale.

Please consider the entire scale when making your responses, as the intermediate levels may apply. For example, if your response is once or twice, the second choice should be marked. If your response is many times but not extremely often, then the sixth box should be marked.

1. Do you easily become deeply involved in movies or tv dramas?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

2. Do you ever become so involved in a television program or book that people have problems getting your attention?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

3. How mentally alert do you feel at the present time?

|_____|_____|_____|_____|_____|_____|_____|

NOT ALERT MODERATELY FULLY ALERT

4. Do you ever become so involved in a movie that you are not aware of things happening around you?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

5. How frequently do you find yourself closely identifying with the characters in a story line?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

6. Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

7. How physically fit do you feel today?

|_____|_____|_____|_____|_____|_____|_____|

NOT FIT MODERATELY FIT EXTREMELY FIT

8. How good are you at blocking out external distractions when you are involved in something?

|_____|_____|_____|_____|_____|_____|_____|

NOT VERY GOOD SOMEWHAT GOOD VERY GOOD

9. When watching sports, do you ever become so involved in the game that you react as if you were one of the players?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

10. Do you ever become so involved in a daydream that you are not aware of things happening around you?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

11. Do you ever have dreams that are so real that you feel disoriented when you awake?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

12. When playing sports, do you become so involved in the game that you lose track of time?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

13. How well do you concentrate on enjoyable activities?

|_____|_____|_____|_____|_____|_____|_____|

NOT AT ALL MODERATELY WELL VERY WELL

14. How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

15. Have you ever gotten excited during a chase or fight scene on TV or in the movies?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

16. Have you ever gotten scared by something happening on a TV show or in a movie?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

17. Have you ever remained apprehensive or fearful long after watching a scary movie?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

18. Do you ever become so involved in doing something that you lose all track of time?

|_____|_____|_____|_____|_____|_____|_____|

NEVER OCCASIONALLY OFTEN

Appendix H

Eudiamonic Well-Being (Waterman et al., 2010)

This questionnaire contains a series of statements that refer to how you may feel things have been going in your life. Read each statement and decide the extent to which you agree or disagree with it. Try to respond to each statement according to your own feelings about how things are actually going, rather than how you might wish them to be.

Please use the following scale when responding to each statement.

Strongly Disagree 0 1 2 3 4 Strongly Agree

1. I find I get intensely involved in many of the things I do each day.
2. I believe I have discovered who I really am.
3. I think it would be ideal if things came easily to me in my life. (R)
4. My life is centered around a set of core beliefs that give meaning to my life.
5. It is more important that I really enjoy what I do than that other people are impressed by it.
6. I believe I know what my best potentials are and I try to develop them whenever possible.
7. Other people usually know better what would be good for me to do than I know myself. (R)
8. I feel best when I'm doing something worth investing a great deal of effort in.
9. I can say that I have found my purpose in life.
10. If I did not find what I was doing rewarding for me, I do not think I could continue doing it.
11. As yet, I've not figured out what to do with my life. (R)
12. I can't understand why some people want to work so hard on the things that they do. (R)
13. I believe it is important to know how what I'm doing fits with purposes worth pursuing.
14. I usually know what I should do because some actions just feel right to me.
15. When I engage in activities that involve my best potentials, I have this sense of really being alive.
16. I am confused about what my talents really are. (R)
17. I find a lot of the things I do are personally expressive for me.
18. It is important to me that I feel fulfilled by the activities that I engage in.
19. If something is really difficult, it probably isn't worth doing. (R)
20. I find it hard to get really invested in the things that I do. (R)
21. I believe I know what I was meant to do in life.

Note: (R) Item is reverse scored.

Appendix I

PTSD Check List – Civilian Version (PCL-C; Weathers et al., 1993)

Instruction to patient: Below is a list of problems and complaints that veterans sometimes have in response to stressful life experiences. Please read each one carefully, put an "X" in the box to indicate how much you have been bothered by that problem *in the last month*.

No.	Response	Not at all (1)	A little bit (2)	Moderately (3)	Quite a bit (4)	Extremely (5)
1.	Repeated, disturbing *memories, thoughts, or images* of a stressful experience from the past?					
2.	Repeated, disturbing *dreams* of a stressful experience from the past?					
3.	Suddenly *acting* or *feeling* as if a stressful experience *were happening* again (as if you were reliving it)?					
4.	Feeling *very upset* when *something reminded* you of a stressful experience from the past?					
5.	Having *physical reactions* (e.g., heart pounding, trouble breathing, or sweating) when *something reminded* you of a stressful experience from the past?					
6.	Avoid *thinking about* or *talking about* a stressful experience from the past or avoid *having feelings* related to it?					
7.	Avoid *activities* or *situations* because they *remind you* of a stressful experience from the past?					
8.	Trouble *remembering important parts* of a stressful experience from the past?					
9.	Loss of *interest in things that you used to enjoy?*					
10.	Feeling *distant* or *cut* off from other people?					
11.	Feeling *emotionally numb* or being unable to have loving feelings for those close to you?					
12.	Feeling as if your *future* will somehow be *cut short*?					
13.	Trouble *falling* or *staying asleep*?					
14.	Feeling *irritable* or having *angry outbursts*?					
15.	Having *difficulty concentrating*?					
16.	Being *"super alert"* or watchful on guard?					
17.	Feeling *jumpy* or easily startled?					

PCL-M for DSM-IV (11/1/94) Weathers, Litz, Huska, & Keane National Center for PTSD - Behavioral Science Division

Appendix J

Satisfaction with Life Scale (Diener et al., 1985)

Instructions: Below are five statements that you may agree or disagree with. Using the 1 - 7 scale below, indicate your agreement with each item by placing the appropriate number on the line preceding that item. Please be open and honest in your responding.

- 7 - Strongly agree
- 6 - Agree
- 5 - Slightly agree
- 4 - Neither agree nor disagree
- 3 - Slightly disagree
- 2 - Disagree
- 1 - Strongly disagree

____ In most ways my life is close to my ideal.
____ The conditions of my life are excellent.
____ I am satisfied with my life.
____ So far I have gotten the important things I want in life.
____ If I could live my life over, I would change almost nothing.

Appendix K

Trait Anxiety Inventory (Zsido et al., 2020)

STAIT-5 (Trait items only)

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the number at the end of the statement that indicates HOW YOU GENERALLY FEEL. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel. Thank you.

Item nr.	Empty Cell	**Not at all**	**Somewhat**	**Moderately so**	**Very much so**
1	I feel that difficulties are piling up so that I cannot overcome them.	1	2	3	4
2	I worry too much over something that really doesn't matter.	1	2	3	4
3	Some unimportant thoughts run through my mind and bothers me.	1	2	3	4
4	I take disappointments so keenly that I can't put them out of my mind.	1	2	3	4
5	I get in a state of tension or turmoil as I think over my recent concerns and interests.	1	2	3	4

Appendix L

Information Letter

Letter of Information and Consent

Title of Research: Virtual reality and meditation for mindfulness and their associations to personality traits

Principal Investigator: Lorne Campbell, PhD. Department of Psychology, Western University.

Co-Investigator: Somer Schaffer, BAs Psychology, Western University.

1. Invitation to Participate
We are asking you to participate in an online study conducted by Lorne Campbell, PhD (the Principal Investigator) and Somer Schaffer, MSc candidate, Western University. This research focuses on associations between the use of virtual reality, meditation, personality characteristics and personal well-being. Funding for this study was provided by Facebook.

2. Purpose of the Letter
The purpose of this letter is to provide you with the information you require to make an informed decision concerning participation in this study.

3. Purpose of this Study
The current research is interested in examining what connections, if any, exist between the use of virtual reality, meditation, certain personality characteristics, and indications of personal well-being. Data for this project will be collected online and will be disseminated through a masters thesis, one or more written reports, and conference presentations.

4. Inclusion & Exclusion Criteria
To be eligible for this study, individuals must be 18 years of age or older, and reside in either Canada or the United States.

5. Study Procedure
This study takes place online on Prolific. Participation involves answering a series of questions assessing participants' demographic characteristics, experiences with virtual reality and meditation, personality characteristics, and indicators of physical and mental well-being. This survey is expected to take 30 minutes. Please do not repeat this survey more than once as you will not receive additional compensation if you do.

6. Possible Risks and Harms
Some of the questions in this survey inquire about information that may be sensitive for some people (e.g., income, education, physical / mental health states). Participants are free to skip any questions that they find objectionable and efforts will be made to ensure that any data that participants provide will remain anonymous and will be kept as confidential as possible.

If any of the materials in this study remind you of difficult personal issues that you would like to discuss, in Canada, you can contact The Lifeline from Crisis Services Canada 24/7 at 1-833-456-4566. The 24 hour Mental Health America helpline at 1-800-273-TALK (8255) is recommended if you are located in the United States.

7. Possible Benefits
Although the information that participants provide may help advance social scientific research, no direct benefits are expected for participants in this research.

8. Compensation
In exchange for your participation, you will receive $4.00. If you close the survey before reaching the end of the study, you will not be able to access the website that will allow you to claim your compensation. As a result, if you wish to discontinue the study we recommend skipping to the end survey so that you can still be compensated.

9. Voluntary Participation
Your participation in the study is completely voluntary and you may choose to stop participating at any time. Your decision not to volunteer, to stop participating, or to refuse to answer particular questions will not influence the nature of any ongoing relationships you may have with the researchers or study staff, or the nature of your relationships with Western University, either now, or in the future. If you decide to stop participating, you may withdraw without penalty, financial or otherwise. In the event you withdraw from the study, all associated data collected will be destroyed wherever possible. Should you wish to withdraw after the study is complete, you will have the option to also withdraw your data up until the analysis is complete. Because identifiable information (Prolific ID) will be immediately destroyed after data collection, there will be no way for participants to withdraw their data from the study. That is, there will be no way to tell which dataset belongs to which participant.

10. Anonymity and Confidentiality
This study is designed to maintain participant anonymity as much as possible. Although the survey will ask for basic demographic information (e.g., gender, age, race/ethnicity, income, year of birth, etc.) participants will generally not be asked for directly identifiable information (e.g., their names, contact information, or their addresses). Responses will be used for research purposes only. In reports of this study, only aggregated group data will be presented. All of your responses will remain confidential. All responses within the surveys are coded with each participants' unique Prolific ID code, which cannot be used by the research team to directly identify you.

Your consent and survey responses will be collected through a third party, secure online survey platform called Qualtrics. Qualtrics uses encryption technology and restricted access authorizations to protect the privacy and security of all data collected and retained, including personal information. In addition, Western's Qualtrics server is in Ireland, which is consistent with Canada's privacy legislation. Please refer to Qualtric's Privacy Policy (https://www.qualtrics.com/privacy-statement/) for more details about Qualtric's information management practices. The data will then be exported from Qualtrics and securely stored on Western University's server. Please note that despite the strong security measures in place, we acknowledge that nothing connected to the Internet is 100% secure. The researcher(s)

acknowledge that the host of the online survey (e.g., Qualtrics LLC) may automatically collect participant data without their knowledge (i.e., IP addresses). Although this information can be provided or made accessible to the researchers, the researchers will not be accessing, collecting, or storing such information for the current project.

The full data that you provide will be collected and stored online and only the researcher will have access to this information. Anonymized data will be stored indefinitely and posted on the Open Science Framework website (OSF; https://osf.io) so that data may be inspected and analyzed by other researchers. The data that will be shared on the OSF website will not contain information that can identify a participant. Confidentiality will be provided to the fullest extent possible by law. The data collected in this research project may be used – in an anonymized form - by members of the research team in subsequent research investigations exploring similar lines of inquiry. Such projects will still undergo ethics review by the Office of Human Research Ethics at Western University and / or the HPRC at York University. Any secondary use of anonymized data by the research team will be treated with the same degree of confidentiality and anonymity as in the original research project.

11. Contacts for Further Information

If you require any further information regarding this research project or your participation you can contact the Principal Investigator, Lorne Campbell, PhD ([redacted]). If you have any questions about your rights as a research participant or the conduct of this study you can contact The Office of Human Research Ethics at Western University, [redacted] (toll-free), or email: [redacted].

12. Publication

If the results of this study are published, your name will not be used, and only group data will be reported.

This Letter of Information is yours to keep for future reference. Please save a copy for yourself.

13. Informed Consent

I consent to participate in the study. I understand the nature of this project and wish to participate. I am not waiving any of my legal rights by agreeing to participate in this study. Clicking 'I agree' below indicates my consent to participate. Clicking 'I do not agree" indicates that I do not agree to participate.

- ○ I agree to participate
- ○ I do not agree to participate

Appendix M

Letter of Debriefing

Virtual reality and meditation for mindfulness and their associations to personality traits

Investigators: Lorne Campbell, Ph.D., Department of Psychology, Western University (Principal investigator) Somer Schaffer, MSc candidate, Department of Psychology, Western University

Thank you for participating in our study examining associations between experiences in virtual reality (VR) and/or meditating and one's personality and personal well-being. Overall, surprisingly little research has evaluated novel VR technologies as a tool for increasing mindfulness and general psychological well-being, for example, reducing anxiety or stress associated with negative life circumstances, which is especially paramount during the COVID-19 pandemic (Seabrook, 2020). Therefore, this study seeks to explore the relationship between VR experiences, meditation experiences, and personality characteristics (e.g., openness, empathy, immersive tendencies) as well as their relation to one's overall well-being (posttraumatic stress disorder symptomatology, anxiety, life satisfaction, and well-being). To address our research goals, you completed a series of questionnaires that assessed your demographics, questions about your experiences using VR and experiences meditating (with or without technology), questions assessing personality characteristics, and your well-being.

If you have questions, would like more information, or would like to be provided with the general results of this study, please email Dr. Lorne Campbell ([redacted]). Please note we will not be able to tell you about your data specifically. If you have any questions about your rights as a research participant or the conduct of this study, you may contact the University of Western Ontario Office of Human Research Ethics by phone ([redacted]) or email ([redacted]). As the research is ongoing, please do not discuss your experiences in this study with other potential participants.

If any of the materials in this study remind you of difficult personal issues that you would like to discuss, you can contact the 24-hour Mental Health America helpline at 1-800-273-TALK (8255) if you are located in the United States. For services in Canada, you can contact The Lifeline from Crisis Services Canada 24/7 at 1-833-456-4566.

Below is a list of references if you would like to read more on these topics:

Cipresso, P., Giglioli, I., Raya, M. A., & Riva, G. (2018). The past, present, and future of virtual and augmented reality research: A network and cluster analysis of the literature. Frontiers in Psychology, 9, 2086–2086. https://doi.org/10.3389/fpsyg.2018.02086

Hurk, P. A. M. van den, Wingens, T., Giommi, F., Barenegt, H. ., Speckens, A. E. ., & Schie, H. T. van. (2011). On the

relationship between the practice of mindfulness meditation and personality: An exploratory analysis of the mediating role of mindfulness skills. Mindfulness, 2(3), 194–200. https://doi.org/10.1007/s12671-011-0060-7

Seabrook, Kelly, R., Foley, F., Theiler, S., Thomas, N., Wadley, G., & Nedeljkovic, M. (2020). Understanding how virtual reality can support mindfulness practice: Mixed methods study. Journal of Medical Internet Research, 22(3), e16106–. https://doi.org/10.2196/16106

Principle Investigator:
Dr. Lorne Campbell
Department of
Psychology
[redacted]

Co-Investigator:
Somer Schaffer, MSc candidate
[redacted]

Thank you again for your time and participation; it is greatly appreciated!

Appendix N

Ethics Approval

Western Research

Date: 29 April 2022

To: Prof. Lorne Campbell

Project ID: 120667

Study Title: Virtual reality for mindfulness and its associations to personality traits

Short Title: Mindfulness, VR, and Personality

Application Type: NMREB Initial Application

Review Type: Delegated

Full Board Reporting Date: 06/May/2022

Date Approval Issued: 29/Apr/2022

REB Approval Expiry Date: 29/Apr/2023

Dear Prof. Lorne Campbell,

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the WREM application form for the above mentioned study, as of the date noted above. NMREB approval for this smdy remains valid until the expiry date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

This research study is to be conducted by the investigator noted above. All other required institutional approvals must also be obtained prior to the conduct of the study.

Documents Approved:

Document Name	Document Type	Document Date	Document Version
Thesis_2022(2)	Online Survey	20/Feb/2022	1
Debriefing- April 14 (1)	Debriefing Document	14/Apr/2022	2
Prolific Recruitment AdV2	Recruitment Materials	14/Apr/2022	2
LOI – April 26 V3	Implied Consent/Assent	26/Apr/2022	3

No deviations from, or changes to the protocol should be initiated without prior written approval from the NMREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario. Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Please do not hesitate to contact us if you have any questions.

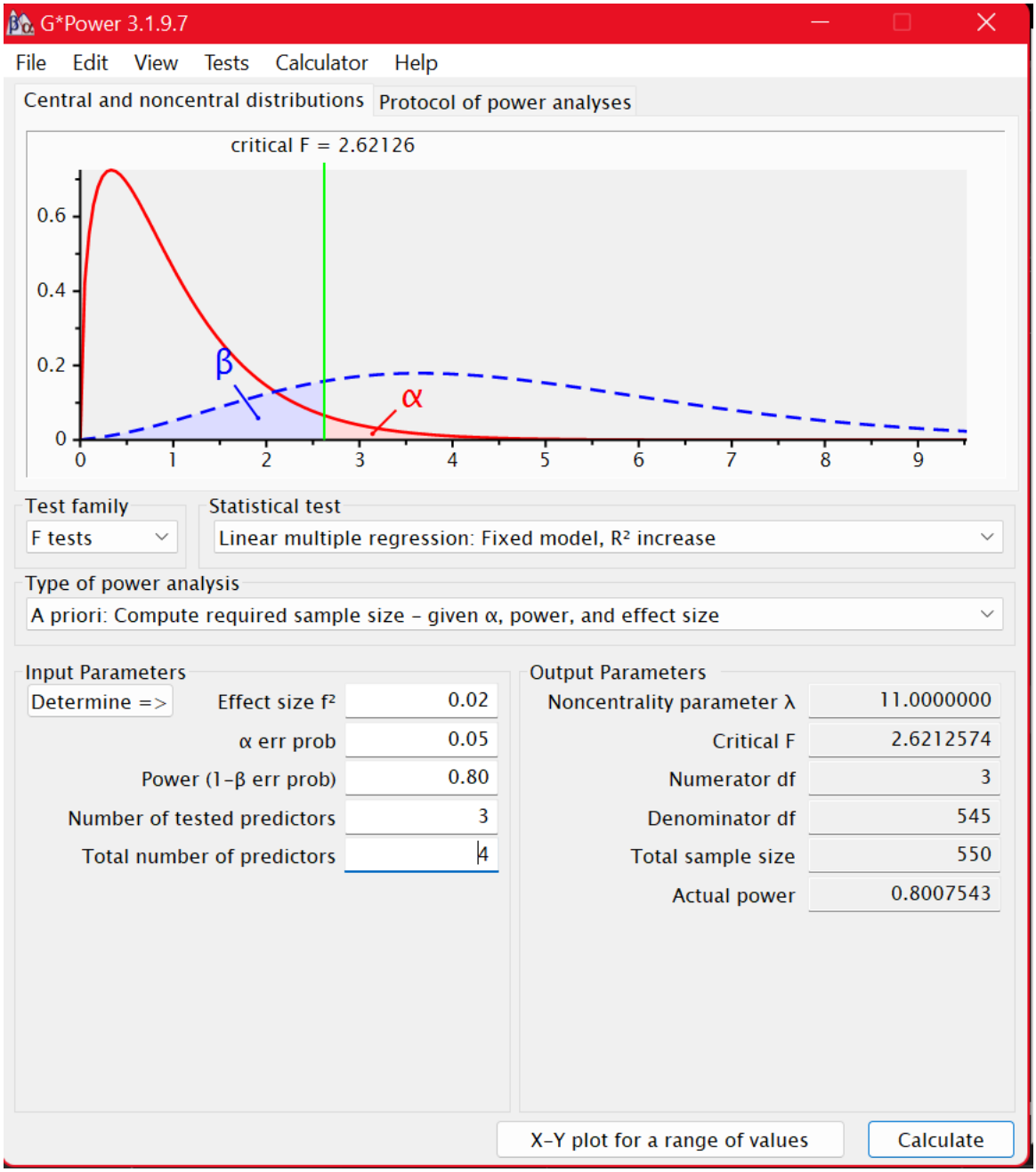
SmcxUy,

Ms. Zoë Levi, Research Ethics Officer on behalf of Dr. Randal Graham, NMREB Chair

Note: This correspondence includes an electronic signature (validation and approval via an online system that is compliant with all regulations).

Appendix O

G*Power A Priori Analysis



Curriculum Vitae

Somer Schaffer

EDUCATION

Master of Science, Social Personality and Developmental Psychology
University of Western Ontario
2020-2022

Bachelor of Arts – Honours Specialization in Psychology
King's University College at Western University
2015-2020

AWARDS AND DISTINCTIONS

Western Graduate Research Scholarship
University of Western Ontario
2020-2022

Honours Thesis Award
King's University College at Western University
2020

King's University College Entrance Scholarship [5,000]
King's University College at Western University
2015

Academic Merit Scholarship [1,500 per year]
King's University College at Western University
2015, 2016, 2019

RELEVANT EXPERIENCE

Graduate Teaching Assistant
The University of Western Ontario
2020-2022

Research Assistant
The University of Western Ontario & King's University College
2019-2022

Graduate Peer Support Committee Member
The University of Western Ontario
2021-current

Research Assistant
King's University College at Western University
2019-2021