Enhancing self-compassion through virtual reality: exploring the impact of personalisation and body satisfaction.

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Thesis Declaration

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Overview

This thesis broadly explores the therapeutic use of virtual reality (VR). It is presented in three main parts.

Part 1: Systematic Review Introduction

An introduction to the therapeutic use of virtual reality, in the form of a systematic review. This review sought to examine how VR interventions are improving mental health in neurorehabilitation and compare factors within the intervention that contribute to positive mental health outcomes. A comprehensive literature search was conducted using pre-determined criteria to identify relevant studies. Findings identified significant heterogeneity in the methods of applying VR in neurorehabilitation. Despite this variation, the findings demonstrate that it can be effectively applied in diverse settings, patient groups, and intervention types.

Part 2: Empirical Paper

A study exploring the impact of avatar personalisation in an immersive virtual reality intervention to promote self-compassion. This research builds on existing evidence highlighting the benefits of an IVR self-compassion intervention, and other research demonstrating the benefits of personalisation in enhancing core features of VR experience, such as body-ownership, sense of presence, and agency. Personalising avatars significantly improved self-criticism, and self-compassion was improved when non-personalised avatars were used. Personalisation did not significantly improve core VR experience features, and the relationship between body satisfaction, avatar personalisation, and self-compassion is more complex than initially anticipated.

Part 3: Critical Appraisal

A reflection and appraisal on the motivations that sparked the research question, and the challenges encountered during the empirical study's methodology, particularly in avatar personalisation and participant recruitment. Furthermore, it shares key moments and observations experienced from the research journey.

Impact Statement

Research

The findings of the systematic review contribute to the growing body of research on the use of virtual reality in rehabilitative settings. While existing research suggests VR's effectiveness in neurorehabilitation, there is a lack of studies that compare methodologies and pinpoint factors that contribute to its success. This review attempts to address this by comparing how VR is applied across studies. The findings provide insights into the variation in using VR as a therapeutic tool and identifies factors that warrant further exploration in future research.

The empirical study reinforces existing research on the effectiveness of IVR interventions in fostering self-compassion. However, it presented new questions regarding avatar personalisation. While personalisation did improve self-criticism outcomes, this effect wasn't directly attributable to changes in the key features of VR experience (such as presence, agency, and body ownership). This unexpected finding warrants further investigation. The findings also revealed a more nuanced link between body satisfaction and avatar personalisation than initially anticipated, thus highlighting the need for further exploration to understand this link.

Clinical

Heterogeneity in methods of applying VR in neurorehabilitation highlights the flexibility and potential of this tool. By identifying factors that contribute to the success of these interventions, clinicians can be guided and empowered to make more informed treatment decisions when implementing a VR intervention in neurorehabilitation.

The empirical study offers promising insights for using VR interventions to improve body satisfaction. While personalisation based solely on facial and body features wasn't sufficient

to enhance the VR experience, it did improve self-criticism. Clinicians may need to incorporate additional components when creating the avatar to enhance personalisation.

Public health

The systematic review highlights VR's potential as an accessible and engaging therapeutic tool. VR interventions can be delivered across diverse settings, in various disciplines, and cater to a range of conditions and demographics. By illustrating the effectiveness of various approaches across the study and compiling them in this review, may inform the development of standardised protocols for applying VR in these settings.

Research suggests a strong link between body dissatisfaction and the risk of developing mental health difficulties. By highlighting promise in improving appearance evaluation, VR self-compassion interventions could serve as a preventative tool. Additionally, the flexible and engaging nature of this IVR intervention holds promise for targeting populations that may not seek out mental health services, potentially improving accessibility to psychoeducation.

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Part One

Introduction

How is immersive virtual reality transforming mental health in neurorehabilitation? A systematic review of the literature.

Abstract

Aims

Virtual reality (VR) has demonstrated efficacy in improving mental health outcomes in neurorehabilitation settings. This systematic review aims to synthesise the literature on the use of VR to improve anxiety, depression and other mental health conditions commonly experienced in neurorehabilitation, and to explore the factors that influence the success of these interventions.

Methods

Embase, Medline, and PsychInfo databases were utilised to perform the search from the period of inception to November 2023. Key search terms included virtual reality, neurorehabilitation, brain injuries, and stroke - generating 3084 articles after removal of duplicates. The screening and exclusion process is detailed on a PRISMA flowchart. The included papers were subject to quality appraisal using the Cochrane risk of bias tool.

Results

16 studies were included in the review, 12 of which reported positive mental health outcomes following a VR based intervention. The demographics, condition, intervention type and mental health outcomes are illustrated and compared. The included studies varied significantly in their patient characteristics, VR technology, and VR based intervention type (cognitive, occupational therapy and motor interventions). The studies are discussed in greater detail according to these factors and in relation to the literature base.

Conclusions

This study identified a high degree of variability in the methods of applying VR in neurorehabilitation settings. Despite this, the majority of studies reported improvements in mental health outcomes following a VR intervention. The findings highlight VR's potential as a flexible and adaptable tool across various patient groups and treatment modalities. Other key findings include the importance of engagement and how features of VR can improve this. Further research is warranted to explore the potential benefits of standardised VR application methods in neurorehabilitation.

Introduction

Neurological conditions such as stroke, brain injury, and neurodegenerative conditions can have long-term physical and psychological impairments, influencing the quality of life of patients and their carers (Gupta et al., 2008; Vogler et al., 2014). Neurorehabilitation is a crucial aspect of care for this population. It involves therapeutic assessment and interventions from various disciplines intending to improve physical and mental functioning, social participation, and independence, rather than focus on reducing impairment (Kitago & Krakauer, 2013). The burden of neurological conditions requiring rehabilitation is considerable, global estimations in 2019 suggest that 255 million individuals are living with neurological conditions that require rehabilitation (Cieza et al.,2020). In 2022, 1 in 6 people were living with a neurological condition in the UK (The Neurological Alliance, 2022). The efficacy of neurorehabilitation has been well-documented, however, there is an ever-growing demand yet a shortfall in provision for this population. In 2018, the shortfall in the UK was believed to be 10,000 beds (APPG on ABI, 2018).

Prevalence and Impact of Mental Health Conditions in Neurorehabilitation

It is widely reported that patients who have experienced neurological accidents or injuries are at risk of developing mental health conditions. Depression and anxiety are common yet pervasive consequences of stroke (Hackett & Pickles, 2014; Knapp et al., 2020), brain injury (Kumar et al., 2018) and neurodegenerative conditions (Baquero & Martín, 2015). There are multiple etiological factors underlying the presentation of these conditions in people undergoing neurorehabilitation, varying from biological mechanisms to psychological adjustment. For biological pathways, it is suggested that elevated inflammatory markers that are associated with depression are characteristic of TBI (Pleines et al., 1998) stroke (Pascoe et al., 2011) and neurodegenerative diseases such as Parkinson's (Hemmerle et al., 2012).

Similarly emotional lability is a common consequence of structural damage to the brain from neurological conditions or injury (Morris et al., 1993).

Psychosocial and adjustment-based factors may also contribute to experiences of anxiety and depression in this population. When experiencing these conditions, patients are often faced with changes in self-concept as a result of sudden or gradual loss of function, which consequentially can impact their identities and ability to participate in selected roles (Nochi, 1998; Muenchberger et al., 2008). Changes related to social connectedness, pain, attractiveness, and sexual function are associated with post-injury psychological distress (Schultz et al., 2022; Naess et al., 2012; Salas et al., 2022). Grief around the loss of prior identities and roles (Coetzer, 2004) and fears of burdening others are common (Kozáková et al., 2019; Wei et al., 2020). Length of hospital admission is also associated with mood and anxiety, in both general hospital patients and patients with brain injury (Albrecht et al., 2015; Shoar et al., 2016), with distress increasing in longer admissions. The impact of cognition and insight is also important to consider, Fleminger et al. (2003) report an association between greater insight and depressed mood in a study of those with brain injury.

Furthermore, traumatic stress disorders such as post-traumatic stress disorder and acute stress disorder (ASD & PTSD) can intersect with these neurological conditions, particularly in patients who have experienced traumatic brain injury. There is inconsistency in the literature base about whether injury that results in impaired consciousness can be classified as PTSD as trauma memories are a key feature of the condition (Price, 1994), however various case and cohort studies document its incidence (Williams et al., 2003). Carrick et al.(2015) outline an intervention for PTSD in those with combat-related brain injury. Similarly, psychosis can be a sequela to neurological injury or disease. Various factors are thought to contribute to psychosis

symptoms in this population. The literature suggests that any disruption to the function in and between limbic, paralimbic, sub-cortical and frontal areas by a condition or disease, could result in psychosis (Arciniegas et al., 2001). As mentioned in the context of depression, there is also a complex etiological background in neurology patients with psychosis, and it is believed genetic vulnerabilities have a role (McAllister & Ferrell, 2002).

The presence of these conditions following neurological injury or conditions can impact the neurorehabilitation process. Research suggests PTSD and neurological injury share similar features which can mutually impact each other, for example, difficulties with memory and concentration, sleep and mood disturbances and increased irritability (Bryant et al., 2011; Mikolić et al., 2019). Consequentially, individuals with both conditions can present with poorer neuropsychological functioning and more severe PTSD symptoms (Vasterling et al., 2018; Mikolić et al., 2019). Additionally, psychosis can have a significant impact on an individual's social functioning and their quality of life. If untreated and alongside a neurological condition, it can impact an individual's ability to engage in rehabilitative treatment or a treatment regime as noted by Gilberthorpe and colleagues (2017) in the context of multiple sclerosis.

Addressing Mental Health Needs in This Population

Taking this into account, it is imperative that patients undergoing rehabilitation be screened for psychological difficulties and any mental health concerns addressed as early as possible. A report by the Neurological Alliance (2022) based on a survey of 8500 people with neurological conditions highlights that 40% did not feel their mental health needs were being met. Psychological distress and mental health conditions can adversely affect motivation and engagement and can impede one's ability to fully engage in rehabilitation. Paolucci et al. (2019) demonstrate that post-stroke depression is an additional disabling factor and accounts for more

than 15% of the additional disability. The rehabilitation trajectory of an individual can be unpredictable, however, it is widely reported that better outcomes are correlated with early intervention (Eghbali et al., 2020; Swarnakar et al., 2023), intensity of therapy (Ballester et al., 2022), and motivation (Verrienti et al., 2023). Having depression during neurorehabilitation is associated with longer hospital stays and poorer efficiency of functional recovery (Sugawara et al., 2015; Wada et al., 2023). Thus lack of engagement or motivation may limit the improvements a patient can make. Psychosocial function is a crucial driver for motor and cognitive improvements in neurorehabilitation (Mann et al., 2023). Therefore, it is essential that rehabilitation for this patient population encompasses mental wellbeing, and should not merely entail functional and medical management.

However, traditional rehabilitation methods can pose challenges when supporting patients with their emotional wellbeing. Rehabilitation is often a long and arduous process for patients, engagement and motivation can fluctuate (Kayes et al., 2022). Inpatient programmes are often time-limited, despite rehabilitation itself often being a long-term endeavour, A UK based case series reported an average inpatient stay of 70.9 days (Taiwo et al., 2018). Similarly, community-based neurorehabilitation in the UK has been described as 'fragmented' (Gladman et al., 2007; Siegert et al., 2014), with families and informal carers experiencing the burden of this. There is a recognised need for novel and innovative means to improve neurorehabilitation.

Recent progress in technology, specifically in Virtual Reality (VR) offers a compelling solution to revolutionise neurorehabilitation and wellbeing. VR is computer technology that allows a user to interact with and become immersed in a virtual environment in a naturalistic setting (Schultheis & Rizzo, 2001). Originally implemented by cinematographer, Mortin Heiling in the 1960s, VR has developed drastically, and in the last decade has become a valuable, cost-

effective tool for various aspects of health care. Its efficacy has been widely documented in various disciplines of care, in medical education to train clinicians (Samadbeik et al., 2018), for patients in physical health settings such as oncology or chronic pain (Niki et al., 2019; Li et al., 2011), and in forensic settings (González Moraga et al., 2022). Furthermore, there is growing interest in virtual reality for mental health conditions such as anxiety and depression (Carl et al., 2019; Jingili et al., 2023), psychosis (Rus-Calafell et al., 2018) and in neurorehabilitation (Voinescu et al., 2021). VR is a promising rehabilitation tool, with desirable features such as ease of use in various environments, non-invasive nature and compatibility with other neurological tools such as exoskeletons. Nevertheless, in clinical and healthcare settings, VR is a maturing field with its potential still evolving.

Defining Concepts of VR

As technology has evolved, what classifies as VR has also changed. Immersion is referred to as one of the three pillars of VR (Mütterlein, 2018), and VR can be classified into three categories based on the degree of immersion. The classifications of immersion are summarised comprehensively by Ma & Zheng (2011).

- Non immersive VR has limited sensory experience, it provides a computer-generated environment displayed on a screen without engaging other senses, often relying on input devices such as a remote.

- Semi immersive VR amalgamates the virtual and physical world and allows for some sensory engagement while remaining partially connected to the real world. The visual content is often displayed using a 360-degree or large screen, using a headset, movement trackers, or a form of simulation device.

- Fully immersive VR engages multiple senses and completely blocks interaction with the real world's physical surroundings, often using a head-mounted display.

- Furthermore, the realm of computer-generated immersive environments extends beyond virtual reality. For example, augmented reality (AR) offers additional features and overlays digital elements in the real world. Unlike VR, the user has a clear view of their physical environment. This can be combined with VR and is referred to as extended reality (XR), which blends virtual and real-world features and offers a highly immersive experience (Mann et al., 2018).

The concept of spatial presence (Steuer, 1995), which outlines the sensation of being inside a virtual environment can also help to distinguish between immersive and non-immersive VR. Immersive VR helps the individual to feel as if they are inside the environment when they look around, while non-immersive VR often requires the user to look around the environment using an inputted device (Kober et al., 2012) such as a remote.

Due to the evolution in technology, there has been a rise in the use of commercial gaming platforms such as the Microsoft Xbox Kinect and Nintendo Wii that can facilitate an interface for VR. These platforms are typically accessible and cost-effective, making them a favourable option in the context of healthcare. However, there is some inconsistency in the literature about whether these should be classed as VR. Regardless, both commercial gaming systems and bespoke VR systems can provide a high degree of salience by minimizing external distractions and allowing users to fully engage with the virtual environment.

The Potential of VR in Neurorehabilitation

Evidence documenting the use of VR in neurorehabilitation is evolving and highlights promising outcomes across various rehab disciplines (Georgiev et al., 2021). For example, its effectiveness can be seen in research around exergaming for motor rehabilitation (Calafiore et al., 2021) with the addition of robotics such as exoskeletons or mobility aids (Mubin et al., 2019) to improve accessibility for this population, as well as the interactivity. In occupational therapy, it has been used to practice activities of daily living (ADL), such as virtual kitchens and supermarkets (Besnard et al., 2016; Levy et al., 2019). Its effectiveness in speech and language therapy to practice conversational skills has been documented (Cappadona et al., 2023). Finally, it can also utilised in psychology for neuropsychological assessment and cognitive intervention (Zhang et al., 2001; Maggio et al., 2019), with literature suggesting it can improve mood and wellbeing (Maggio et al., 2020). Studies exploring VR in this context suggest both biological and psychosocial mechanisms underpinning its effectiveness, such as the neural reorganisation in the brains of patients (Gatica-Rojas & Méndez-Rebolledo, 2014), improvements in physical function through activity (Grealy & Heffernan, 2001), and evoking positive emotions through self-development and activities such as art, relaxation and entertainment (Georgiev et al., 2021).

Aims

This systematic review aims to better understand how VR is transforming mental wellbeing in neurorehabilitation. Many studies report that VR interventions have positive outcomes on mental wellbeing and speculate on why this might be, however, few compare patient and intervention characteristics to understand when and why it might be effective. This review will compare studies that use different types of VR, therapies, and patient groups, and have different outcomes, to explore this aim.

Methods

This systematic review was conducted as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

Search Strategy

Publications from Embase, Medline and PsychInfo databases from inception to 2023 were searched on the 6th November 2023. Due to the variety of terms used to describe mental health and the limited publications found during a trial search, the decision was made to broaden the search by excluding any reference to mental health in the literature search, and instead during the screening process publications that did not include a mental health component were excluded. This was to reduce the risk of bias resulting from the search strategy. The search strategy was as follows, (1) Virtual Reality (expand) /, (2) "virtual realit*", (3) 1 OR 2, (4) neurorehabilitation /, (5) "neurorehab*", (6) brain injuries /, (7) "brain injur*", (8) "stroke*", (9) 5 OR 6 OR 7 OR 8, (10) 3 AND 9.

Study Selection

All relevant results were exported with titles, abstracts, and keywords to rayyan.ai, a mobile platform for facilitating systematic reviews. Initial screening of abstracts was completed based on pre-determined exclusion criteria discussed with a supervisor and a second reviewer (peer co-researcher). The exclusion criteria for initial screening were as follows: (1) The publication was not primary research (e.g. meta-analyses, systematic and narrative reviews, and protocols); (2) The intervention modality did not include VR; (3) The tested population were not undergoing neurorehabilitation; (4) The tested population included those under 18; (5) The outcome or measure used was not related to mental health or wellbeing; (6) The publication was not in English. Additionally, studies that utilised AR and XR were eligible for inclusion.

At the point of full-text screening, studies that did not use immersive or semi immersive VR were excluded using a criterion agreed with a peer co-researcher. The criteria were as follows; Fully immersive VR must use a head mounted device or similar, with real-time tracking of motion that allows the user to be disconnected from their real-world physical surroundings, they can control the virtual environment by looking around; Semi immersive VR must use a projector or large screen and not rely solely on auditory and visual means of engaging, similarly VR that requires inputted devices such as mouses and remotes that require the user to use to view the virtual world will not be classed as semi immersive. Studies that solely focused on Quality of Life (QoL) were not included as the literature base makes a clear distinction between QoL and mental health.

The process of full-text screening was supported by the second reviewer who independently and blindly reviewed the full-text articles. Any conflicts were resolved by consensus.

Data Extraction

Information extracted from eligible papers included: (1) Title; (2) Authorship; (3) Year; (4) Country; (5) Research question; (6) Participant demographics and neurological condition; (7) Intervention setting; (8) VR type and model; (9) Description of intervention; (10) Mental health outcome measures (e.g. HADS, BDI); (11) Results.

Study Quality Assessment

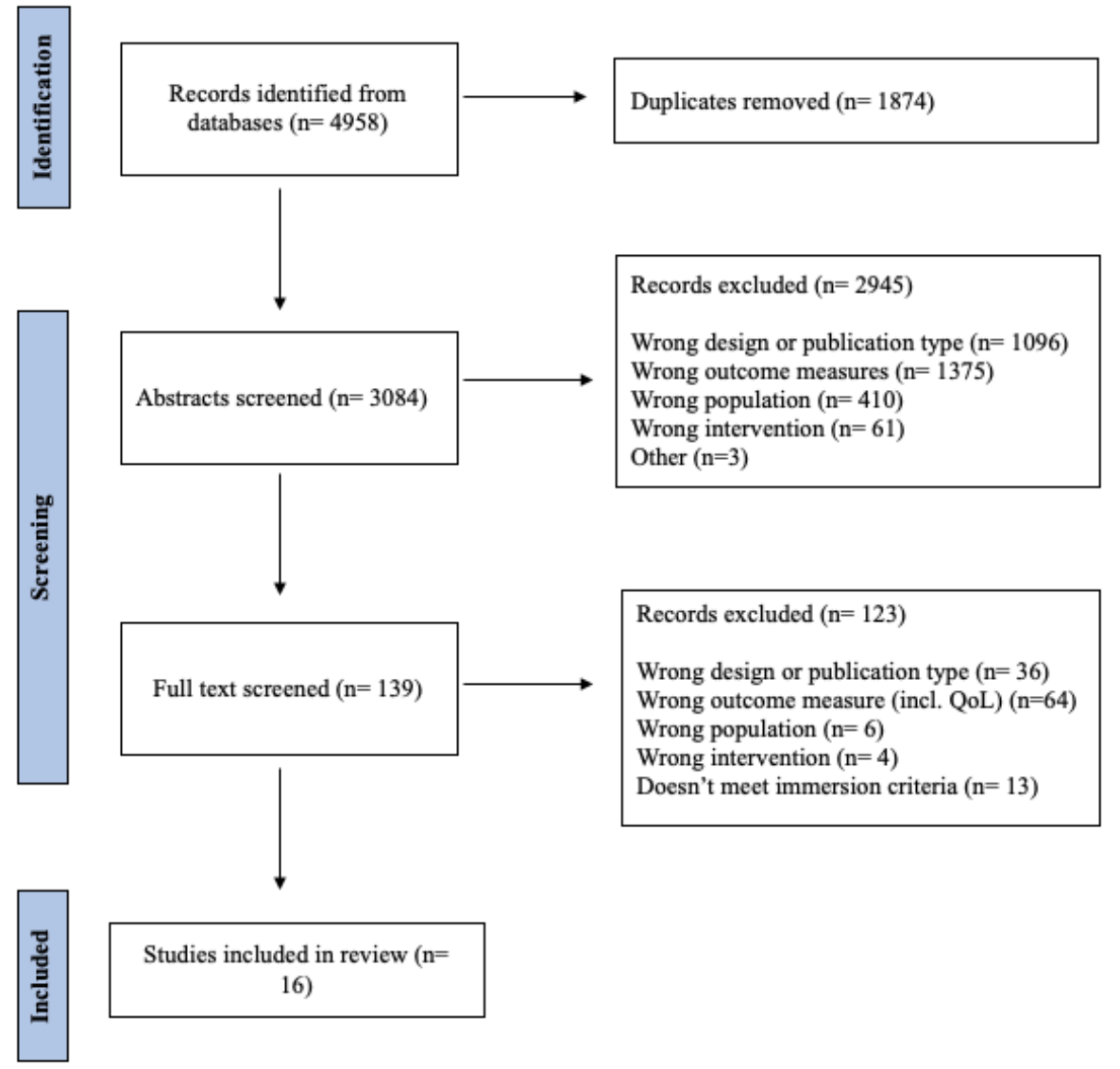
The included studies were assessed for risk of bias using the Cochrane Risk of Bias Tool ROB2 (Sterne et al., 2019) and the ROBINS-I tool for non-randomised studies (Sterne et al., 2016).

Results

Database searches yielded 4958 titles and abstracts. Following the removal of duplicates, 3,084 abstracts were screened. A total of 139 articles were full text screened for eligibility. This led to the identification of 16 articles for inclusion in this systematic review. Figure One outlines a PRISMA flowchart of the screening process.

Figure One:

PRISMA Flow Chart Outlining The Identification, Screening and Inclusion Process.



A total of 862 participants were included in the 16 studies. 496 participants took part in a VR intervention, 366 participants took part in an alternative intervention as a control, and 20 took part in a VR intervention but were a control group of healthy volunteers. 11 of the studies involved stroke rehabilitation patients, one involved brain injury rehabilitation patients, three involved patients with neurodegenerative conditions, and one involved a spinal cord injury patient. All of the publications included were quantitative studies. The type of study varied 12 were randomised control trials (RCT), and four were non-randomised studies. In the RCTs, one study compared a neurorehabilitation group with a healthy control group using VR, whereas the remaining RCTs compared VR with other interventions or with various types of VR.

The search identified studies using AR and XR, however upon further exploration, none met the specific criteria related to mental health focus, neurorehabilitation setting, and publication type. Thus, they were excluded.

Mental Health Impact

Although this review was interested in exploring any mental health condition in people undergoing neurorehabilitation, all of the studies that remained after screening measured either anxiety or depression symptoms. 15 of the included studies included a measure of depression and seven included a measure of anxiety. The measures applied included; 1. *The Hospital Anxiety and Depression Scale (HADS)*. 2. *The Hamilton Rating Scale for Anxiety (HAM-A).* 3. *The Hamilton Rating Scale for Depression (HAM-D).* 4. *The Beck Depression Inventory (BDI).* 5. *The Geriatric Depression Scale (GDS-30)*.

12 of the included studies reported an improvement in either depression or anxiety scores on their respective measures. No studies documented an increase in depression or anxiety in VR

groups, however, a total of five studies found no significant between-group differences when VR was compared with a control. One study (Maier et al., 2020) noted an increase in scores on the HAM-D scale for the control group (who participated in standard at-home cognitive tasks), which wasn't observed in the VR group.

Comparing the Applications of VR

When extracting the data it was apparent that there was heterogeneity in the methods of applying VR in this setting across the included studies. Three themes became apparent when considering the factors that may influence the success of a VR intervention in this setting, these include; 1. *Patient pathology and characteristics.* 2. *Technological factors.* 3. *Type of intervention*. These themes will be outlined further in the discussion section, with reference to the included studies and existing literature.

A summary of the characteristics of included studies is presented in Table One and the types of interventions used in the studies are outlined in Table Two.

Risk of bias

A summary of the risk of bias assessment outcomes is presented in Figures two and three. At least eight of the studies report challenges in blinding either participants and personnel or both to the studies, which may be a limitation. Five of the RCTs do not report a randomisation sequence. Overall the risk of bias is moderate.

Table One: *Characteristics of Included Studies.*

Author	Pathology	Participant Demographics	Intervention	VR Device & Degree of immersion	Measure of Mental Wellbeing	Main Outcome
Adomavicien e et al., 2019	Stroke	42 participants (25 in EG) Mean age: total 64 years, VR group 62 years F: 14 / M: 28	Motor Intervention	Microsoft Xbox Kinect for Windows Software Development Kit (webcam, depth sensor, microphone) Semi Immersive	Hospital Anxiety and Depression scale (HADS)	There was a significant difference in anxiety scores within groups after the interventions. This difference was greater for the VR group (vs the robotic group).
Ballester et al., 2016	Stroke	18 participants (all VR – 9 with adaptations) Mean age: total 59.1 years, VR group 63.4 years F: 3 / M: 15	Motor Intervention	Microsoft Kinect and projector Semi Immersive	Hamilton Rating Scale for Depression (HAM-D)	There were no significant between or within group differences in depression scores between the groups with movement amplification and no movement amplification (both VR groups).
Bruschetta et al., 2022	Traumatic Brain Injury	100 participants (50 VR) Mean age: total 39.9 years, VR group 38.7 years F: 44 / M: 56	Cognitive Therapy	BTS-Nirvana Semi Immersive.	Hamilton Rating Scale for Anxiety (HAM-A)	There was a VR related improvement in mood and cognitive flexibility. A significant group (VR vs non-VR) * gender interaction effect was noted. Females had a lower reduction in anxiety compared to males after the VR intervention.
Dehn et al., 2020	Stroke	40 participants (all VR, 20 healthy controls) Mean age: total 58.1 years, Healthy controls 56.9 years F: 22 / M: 18	Cognitive Therapy	Octavis Semi Immersive	Beck Depression Inventory – II (BDI-II)	There was a significant decrease in depression symptom scores after the intervention in both the patient group and healthy controls. However there were no significant between group differences.
De Rooij et al., 2021	Stroke	50 participants (27 VR) Median age: total 63 years,	Motor Intervention	GRAIL Fully Immersive	Hospital Anxiety and Depression scale (HADS)	There were no significant differences in anxiety and depression between VR treatment group and control.

		VR group 65 years F: 14 / M: 36				However increased participation was observed.
Formica et al., 2023	Parkinson's Disease	31 Participants (all VR) Median age: total 61 years F: 13 / M: 18	Motor & Cognitive Intervention	CAREN Fully Immersive	Hamilton Rating Scale for Depression (HAM-D)	There was a significant within group difference in depression scores for time. Depression scores improved. The paper also included the COPE (Coping Orientation to Problems Experienced Scores) scale and various correlations were noted.
Kamble et al., 2021	Stroke	20 participants (10 VR) Mean age: total 53.4 years, VR group 54.2 F: 8 / M: 12	Motor & Cognitive Intervention	Head-mounted VR device Fully Immersive	Hamilton Rating Scale for Anxiety and Depression (HAM-A & HAM-D)	There were no significant differences in anxiety and depression scores between VR group and control group.
Kiper et al., 2022	Stroke	60 Participants (30 VR) Mean age: total 65.5 years, VR group 65 years F: 30 / M: 30	Psychological intervention	Head-mounted VR device (HTC VIVE PRO) Fully Immersive	Hospital Anxiety and Depression Scale (HADS) & Geriatric Depression Scale (GDS-30)	There was a significant reduction in GDS-30 and HADS-A scores following the VR intervention at follow-up. There was a significant reduction in HADS-D scores from pre to follow-up only. A time* group interaction effect was significant on the GDS-30, the VR group had a greater reduction over time.
Lin et al., 2020	Stroke	145 participants (38 VR) Mean age: total 65.7 years, VR group 64.5 years F: 58 / M: 87	Motor & Cognitive Intervention	Microsoft Xbox Kinect patient image projected to a monitor Semi Immersive	Hospital Anxiety and Depression Scale (HADS)	There was a significant reduction in anxiety and depression in the VR group post-intervention. There was also a significant group * interaction effect, for depression and anxiety, with the VR group reporting a greater decrease (controlling for baseline heterogeneity)

Maggio et al., 2023	Spinal Cord Injury	42 Participants (21 VR) Mean age: total 58.6 years, VR group 58.6 years F: 20 / M: 22	Cognitive Intervention	BTS-Nirvana Semi Immersive.	Beck Depression Inventory (BDI)	There was a significant difference in mood between the VR group and control group post-intervention. Participants were categorised based on the severity of their injury (ASIA A & B). Post intervention there was a significant difference in mood for VR participants with the severest injury rating (ASIA A), this was not the case for the less severe injury rating group (ASIA B). However, in control group ASIA B, there was no significant difference in depression scores in the VR group.
Maggio, Stagnitti et al., 2023	Secondary Progressive Multiple Sclerosis	106 participants (53 VR) Mean age: total 51.3 years, VR group 49 years F: 48 / M: 58	Cognitive intervention	BTS-Nirvana Semi Immersive.	Hamilton Anxiety Rating Scale (HAM-A) & Beck Depression Inventory (BDI)	There was a significant group * time interaction effect for scores on BDI, but not on HARS. In the VR group there was a significant within group difference on the BDI, but not the HARS. There was no significant reduction in anxiety or mood in CG.
Maier et al., 2020	Stroke	38 participants (19 VR) Mean age: total 65.42 years, VR group 63 years F: 15 / M: 23	Cognitive intervention	Microsoft Xbox Kinect Tobii Eyetracker T120 Semi Immersive	Hamilton Depression Rating Scale (HAM-D)	There were no significant within group differences in depression in the VR group post intervention and at follow up. However, depression scores increased for the control group. There was a significant difference between groups at T1 and originally a significant difference in depression scores between the groups at T2, that was lost after controlling for one extreme outlier.

Saladino et al., 2023	Multiple Sclerosis	54 participants (14 in remote phase 2) Mean age: total 44.7 years, Phase 2 41.7 years, F: total: 31, Phase 2: 6 / M: total: 23, Phase 2: 8	Motor Intervention	Microsoft Kinect with Orbbec optical tracking device, Leap motion for fine motor tracking and VirtualRehab® software Semi Immersive	Beck Depression Inventory – II (BDI-II)	There were significant within group differences in depression scores pre and post institutional VR. For those that continued in the phase 2 remote group, there was a further significant reduction in depression scores.
Shin et al., 2015	Stroke	32 Participants (16 VR) Mean age: total 53.9 years, VR group 53.3 years F: 8 / M: 24	Occupational Therapy Intervention	RehabMaster™ 3D sensors and depth sensors, patient image project to screen Semi Immersive	Hamilton Depression Rating Scale – Korean version (HAM-D)	There was a significant within group difference, with depression scores decreasing post-intervention . However, there were no between group differences between the VR group and the control.
Song & Park, 2015	Stroke	40 participants (20 VR) Mean age: total 50.7 years, VR group 51.37 years F: 18 / M: 22	Motor intervention, through exergaming	Micorsoft Xbox Kinect sensor and associated Kinect games Semi Immersive	Beck Depression Inventory (BDI)	There were significant within group differences in depression scores in both VR and the exercise control group, with depression scores decreasing post-intervention. The VR group demonstrated a greater improvement in BDI scores.
Wu et al., 2022	Stroke (with a diagnoses of PSD)	44 participants (22 in 2D condition) Mean age: 51.34 years F: 17 / M: 27	Unspecified Intervention	Head-mounted device (VIVE) Fully Immersive	Hamilton Depression Rating Scale (HAM-D)	There was a significant time * group effect, with the 3D-VR group demonstrating a decrease in depression scores post-intervention. FMRI shows increased effective connectivity in 3D group.

Table Two: *Details of The Interventions Used in The Included Studies.*

Author	Details of VR Intervention	Details of Control
Adomaviciene et al., 2019	Training through exergaming to promote natural human movements with entertaining games using Microsoft Kinect.	Conventional rehabilitation programme with a robot assisted trainer.
Ballester et al., 2016	The Micorsoft Kinect is used to practice five scenarios that aimed to promote voluntary or forced use of the limb with paresis. The experimental group experienced this with movement amplification to maximise affected limb use	The same intervention as the experimental group but without movement amplification.
Bruschetta et al., 2022	The VR group performed cognitive exercises by interacting with five virtual scenarios on an interactive screen to practice inhibitory control, create simple associations (letter-colour), divided attention, arithmetic operations and deductive reasoning.	Traditional cognitive rehabilitation. The control group practiced the same tasks but using pen and paper.
Dehn et al., 2020	A learning task, participants memorised a shopping list and entered a virtual supermarket where they were required to recall the shopping list and identify as many of the products as they could.	The control group were healthy volunteers.
De Rooij et al., 2021	The Gait Real-time Analysis Interactive Lab (GRAIL) which comprises of a treadmill with a harness to provide weight support, a 180 degree screen for projection of 3d environments. There were various rehabilitation applications to practicereactive balance maneuverability, or dual tasks.	Conventional treadmill training and functional gait exercises.
Formica et al., 2023	The computer-assisted rehabilitation environment (CAREN) consists of a treadmill, a moveable platform, motion capture system and 180 degree screen. Participants underwent six virtual training scenarios that focused on walking, balance, coordination, load distribution, muscle strength, proprioception, visuo-spatial orientation, visuo-spatial attention and action planning.	N/A
Kamble et al., 2021	Conventional rehabilitation in addition to VR induced environmental and habitual navigation that required participants to remember the environment. Tasks involved exercising of the upper and lower limbs and relaxation.	Conventional physiotherapy.

Kiper et al., 2022	Conventional rehabilitation in addition to immersive therapeutic garden relaxation exercise.	Conventional rehabilitation and they practiced an audio desensitization relaxation technique.
Lin et al., 2020	Early multi-disciplinary neurorehabilitation and five additional days of VR rehabilitation which involved training muscle strength of upper and lower limbs, cognition and coordination, using 3D virtual scenarios.	Early rehabilitation alone.
Maggio et al., 2023	Standard physical treatment and virtual cognitive training which included exercises based on memory, attention and executive processes in various scenarios.	Standard physical treatment and traditional pen-to-paper cognitive exercises based on memory, attention, and executive processes.
Maggio, Stagnitti et al., 2023	Standard physical warm up alongside virtual cognitive training, to program finalised movements practicing manipulation of objects, creating associations,	CG had standard physical warmup traditional cognitive rehabilitation using pen-paper tasks. This involved movement of specific objects, around specific spaces and creating associations.
Maier et al., 2020	A rehabilitation gaming system using various virtual scenarios to practice attention and memory tasks, speed of processing, sustained attention, visual searching (alerting in spatial neglect), and problem solving.	CG received 30 home-based cognitive tasks including crosswords, complete the sentence exercises, draw complex figures exercises and spot-the-difference, to practice spatial awareness, attention, memory, executive abilities.
Saladino et al., 2023	Phase 1 consisted of exergaming which focused on gross motor and fine motor activities. Applied for ‘body’ and ‘hands’. Phase 2 consisted of telerehabilitation, implemented in the same manner with just ‘body’.	N/A
Shin et al., 2015	Conventional OT with an additional 30 minutes of VR gaming which encouraged active trunk and arm movements.	Conventional OT, but with an additional 30 minutes.
Song & Park, 2015	The VR group did 30 minutes of gaming using the Microsoft Kinect. Participants practiced balance and movement.	CG trained using ergometer bicycle that used MOTOMed, a device providing biofeedback and software controlled therapy programmes.
Wu et al., 2022	Conventional rehabilitation plus immersive 3D VR motor intervention. Participants were required to select fruits corresponding to sound or text commands in a virtual living room.	Conventional rehabilitation plus 2d VR motor intervention involving a paretic hand on an end effector and with a screen. Participants reached the fruit displayed on the screen with the virtual hand.

Figure Two.

Risk of Bias Summary of The Included Randomised-Controlled Studies Using The ROB2 Tool.

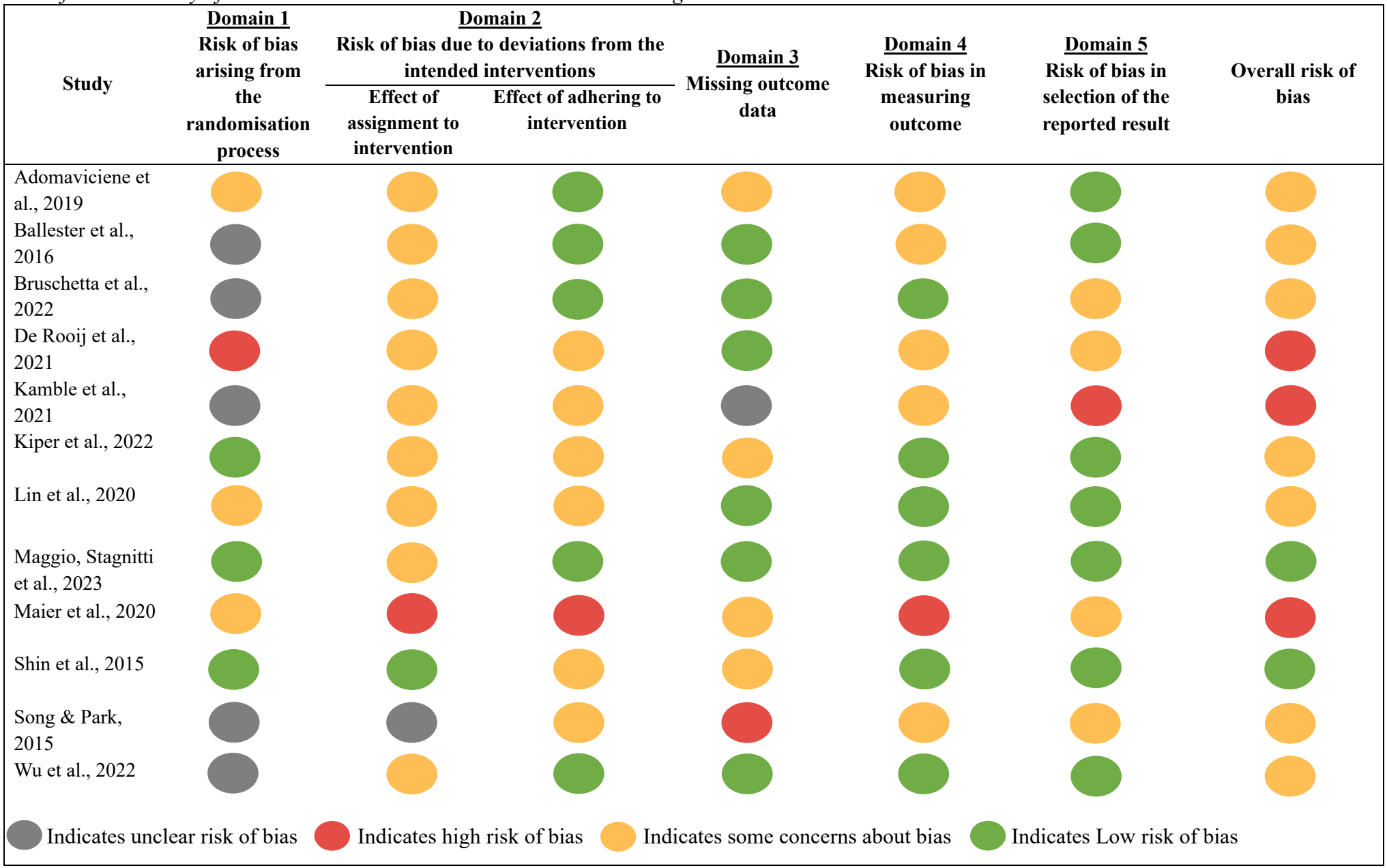


Figure Three.

Risk of Bias Summary of the Included Non-Randomised Studies Using The ROBINS-I Tool.

Study	Risk of bias due to confounding	Risk of bias in selection of participants	Risk of bias in classification of interventions	Risk of bias due to deviation from intended interventions	Risk of bias due to missing data	Risk of bias in measuring outcomes	Risk of bias in selection of reported results	Overall risk of bias
Dehn et al., 2020								
Formica et al., 2023								
Maggio et al., 2023								
Saladino et al., 2023								

Discussion

Existing literature indicates that integrating VR into neurorehabilitation has promising outcomes in physical function and psychological wellbeing. This review mostly corroborates this view, in that 12 of the included studies noted an improvement in mental health (either depression or anxiety outcome scores) following a VR neurorehabilitation intervention. When compared with a control intervention, VR interventions were not always superior at reducing depression or anxiety scores in this population, however, no deteriorations in mental health symptoms were recorded in the VR interventions included in this study. The three studies with the lowest risk of bias (Maggio, Stagnitti et al., 2023; Saladino et al., 2023; Shin et al., 2015) align with these findings and collectively strengthen the evidence base for the efficacy of VR in this context.

This systematic review concerns the factors that may contribute to the success of VR interventions in this setting. The studies will be discussed in relation to three key themes that were apparent in the outcomes of the included studies.

Patient Pathology and Characteristics

It is documented that VR interventions may be more effective for specific demographics.

One of the papers included in this study explores differences between males and females when using their VR intervention with people with traumatic brain injury (Bruschetta et al., 2022). They reported a significant gender x group effect, with females demonstrating a lower reduction in anxiety post VR intervention compared to males. The observed effect could be attributed to broader findings relating to sex differences in cognitive and health outcomes post-neurological injury. The literature indicates that females are more likely to have poorer health outcomes (Farace & Alvez, 2000) and a higher likelihood of being diagnosed with anxiety

and/or depression following a brain injury (Shi et al., 2017; Liossi & Wood, 2009). This suggests that females have a different post-injury experience to males, possibly accounting for the difference in mental wellbeing outcomes in the VR intervention.

Regarding age, the research on VR effectiveness in neurorehabilitation for various groups is inconclusive. Previously, it was assumed that older people lack familiarity and confidence using digital interventions such as VR (Lee et al., 2003; Lepkowsky & Arndt, 2019), and historically have shown a preference for conventional, less 'childish' interventions (Laver et al., 2011). However, this is now felt to be an outdated perspective and VR interventions have been shown to be effective in older populations (Neri et al., 2017). In the context of this review, it is not possible to derive a conclusion that supports or refutes an age effect as none of the included studies controlled for age. However, observation of the demographics and findings of the included studies suggest that there are no superiority effects of age. For example, the three studies with the lowest participant mean age (below 50.7 years old) all had positive outcomes, and in the studies with the highest participant mean or median age (above 65 years old) two out of three studies also noted positive outcomes. Nevertheless, Plechatá et al. (2019) identified that older participants of their study showed a preference for less immersive interventions, such as those that use a desktop screen rather than a head mounted device (HMD). The impact of immersion is explored further in subsequent sections.

Furthermore, there is a paucity of evidence that indicates that VR interventions are more or less effective in specific neurological conditions or injuries. When comparing the various neurological conditions or injuries from the included studies, there does not seem to be a consistent pattern where VR is more effective for the various groups, however, the most studied condition in this review was stroke. Seven out of the 11 stroke-focused studies reported

significant within-group reductions in anxiety and/or depression scores post-intervention (Advomavicine et al., 2019; Dehn et al., 2020; Kiper et al., 2022; Lin et al., 2020; Shin et al., 2015; Song & Park, 2015; Wu et al., 2022). Additionally, Four of these studies reported significant between-group differences between VR and control interventions (Advomavicine et al., 2019; Kiper et al., 2022; Lin et al., 2020; Wu et al., 2022), potentially indicating that VR interventions are not superior to other interventions for those with stroke. This is consistent with existing literature that explores other aspects of stroke rehabilitation (Laver et al., 2017).

In the remaining studies that included participants with neurodegenerative conditions or brain or spinal injury, there were insufficient articles to make inferences about patterns (n=5). In the three articles that included patients with neurodegenerative conditions, depression scores significantly reduced post-intervention (Formica et al., 2023; Magio et al., 2023; Saladino et al., 2023). In the single study that included brain injury patients, there was a significant VR related improvement in mood (Bruschetta et al., 2022). Similarly, in the study that included participants with spinal cord injury, a significant difference in depression scores was found in the VR group, and this difference was greater for those who were categorised as having the most severe classification of injury, which was not apparent in the non-VR control group (Maggio et al., 2023). The authors of this study hypothesise that the difference in the groups may be related to greater improvements in quality of life. Research also suggests that injury-specific factors such as the side of the brain impacted can influence responses to VR interventions (Fernandes et al., 2014). Thus, it is possible that the specific features of an impairment or the severity of an injury may contribute to mental health outcomes when using VR in neurorehabilitation.

One of the included studies also highlights no significant differences in mental health outcomes on a VR intervention between neurorehabilitation patients and healthy controls (Dehn et al., 2020). Considering these findings, it can implied that VR neurorehabilitation interventions are widely successful in improving the wellbeing of patients with a variety of demographic characteristics and with various conditions.

Technological Factors

A diverse range of VR systems and interfaces were used across the studies in this review, which may have impacted the success or challenges in improving mental wellbeing when adopting this technology in neurorehabilitation. Firstly, there was a spectrum of immersion. Five studies utilized systems that were classed as being fully immersive, using head-mounted devices and motion platforms. 11 studies utilized semi-immersive systems, using commercially available game platforms with motion and eye-tracking, 'sensory rooms' with projections and motion trackers, and 360-degree screens.

Only one of the included studies directly quantified or explored the impact of immersion by comparing a two-dimensional intervention with a three-dimensional intervention in stroke patients (Wu et al., 2022). The authors found an increased improvement in depression scores in the three-dimensional VR group and compared functional-magnetic imaging of the participants in each group, highlighting increased effective connectivity in emotional networks in the three-dimensional intervention group which was not observed in the two-dimensional group. The findings not only support the use of interventions with higher degrees of immersion but also the significance of neural modulation for post-stroke depression. Similar findings are reported in studies comparing two and three-dimensional interventions in patients with

Parkinson's disease, suggesting that three-dimensional interventions bring increased interest and enjoyment (Cikajlo & Peterlin Potisk, 2019).

Although none of the other included articles directly quantify or compare immersion levels, observations of the outcomes of the two VR groups do not suggest less immersive interventions are futile. In the fully immersive category, three out of five studies included in this review noted positive within group outcomes (Formica et al., 2023; Kiper et al., 2022; Wu et al., 2022), and in the semi-immersive category, nine out of 11 reported positive outcomes (Adomaviciene et al., 2019; Bruschetta et al., 2022; Dehn et al., 2020; Lin et al., 2020; Maggio et al., 2023; Maggio, Stagnitti et al., 2023; Saladino et al., 2023). This observation is concordant with findings from a meta-analysis by Rose, Nam and Chen (2018) which reports mixed outcomes when investigating the impact of the level of VR immersion on health and user performance outcomes. Although immersive VR may increase one's experience of presence, this may have negative implications for this population. Makransky et al. (2019) found that higher levels of immersion may lead to cognitive overload when completing tasks in VR. Therefore, an unforeseen consequence of high levels of immersion may be fatigue, which is commonly reported in this population (Juárez-Belaúnde et al., 2024). However, there is a benefit to this as higher levels of immersion may better reflect the real world and have greater ecological validity, which is important in the context of functional rehabilitation.

The literature base also suggests that 'bespoke' VR systems are superior to commercially available platforms such as the Microsoft Kinect, suggesting that bespoke systems are more likely to adhere to VR principles (Voinescu et al., 2021). However, technological advancement has meant that commercial gaming systems have become increasingly sophisticated and integrate the features that were once exclusive to 'bespoke' VR systems. In the current review,

six of the studies that were classified as semi-immersive utilised the Microsoft Kinect with features including projectors, eye trackers and fine-motor trackers. Four of these studies reported significant within group reductions in anxiety or depression (Adomaviciene et al., 2019; Lin et al., 2020; Saladino et al., 2023; Song & Park, 2015), potentially illustrating this equivalency of capabilities. Another possible explanation may be in relation to the enjoyability of interventions, commercial platforms such as the Kinect are likely to be used to facilitate serious games or exergaming, this will be explored further in subsequent sections. Nonetheless, there still lacks agreement about whether commercially available platforms can be classed as VR.

Ultimately, there are benefits and drawbacks to using each type of VR. However, we can summarise that user experience is a crucial aspect, and factors such as infrastructure, comfort and personalisation are important.

Type of Intervention

The review identified a diversity of VR rehabilitation approaches across the various studies included.

Firstly, the studies can be categorised into three different types of interventions. five were solely motor or physiotherapy-related interventions, five were solely cognitive interventions, three included aspects of both cognitive and motor therapy, and three were other interventions such as occupational therapy or mood/emotional wellbeing related. Five of the motor interventions (including two mixed cognitive and motor) reported significant differences in mental health (Adomaviciene et al., 2019; Formica et al., 2023; Lin et al., 2020; Saladino et al., 2023; Song & Park, 2015). It is widely reported that exercise is a feasible therapeutic

approach and yields various cognitive, mood, and neuroprotective-related benefits in neurorehabilitation populations (Reynolds et al., 2016; Cobianchi et al., 2017). Six out of eight of the cognitive interventions (including two mixed cognitive and motor) reported significant improvements in mood following VR interventions (Bruschetta et al., 2022; Dehn et al., 2020; Formica et al., 2023; Lin et al., 2020; Maggio et al., 2023; Maggio, Stagnitti et al., 2023). Additional measures applied in some of the papers indicate correlations between improved mood and increased cognitive flexibility and coping strategies (Bruschetta et al., 2022; Formica et al., 2023). VR provides a creative and accessible means to access each of these types of interventions.

Moreover, the included studies revealed the potential benefits of using VR as part of a multimodal intervention strategy in neurorehabilitation. Four of the studies utilised VR in adjunct to conventional therapies, and each reported positive outcomes. In Kiper et al. (2022), all participants underwent functional rehabilitation before experiencing their respective interventions, a significant time and group interaction effect was observed, with greater reductions in depression scores apparent in the VR group. Similar findings were reported in Maggio, Stagnitti et al. (2023) in that, a significant time and group interaction effect was reported, with the VR group reporting a greater reduction in depression scores, and in Maggio et al. (2023) where a significant difference was observed between the VR group and control. No between-group differences were apparent in the occupational therapy study by Shin et al. (2015) however, the VR group still had significant improvements in depression scores. These observed effects may be related to enjoyment, as outlined above, or through providing variation and avoiding interventions from feeling habitual which can impact motivation (Oyake et al., 2023).

Some of the approaches in the various studies included may have had higher engagement potential than others which may account for differences in mental health outcome across studies. For example, in Maier et al. (2020) the experimental group intervention involved rehabilitative games on a semi-immersive VR platform, whereas the control group completed paper cognitive tasks such as crosswords. Similarly, in Kamble et al. (2021), the experimental group experienced environmental training and relaxation with VR headsets, while the control group had conventional therapy with a therapist while lying or sitting on a bed. It is possible that the difference in experienced enjoyment of the interventions in these studies contributed to the variation observed. Engagement is an important factor in the success of VR interventions (Danzl et al., 2016). Factors that have been found to increase engagement include interactivity (Zimmerli et al., 2013) and competition for improving motivation (Mouatt et al., 2020). Interventions that include aspects of positive gameplay can also support mood due to dopamine releases which contributes to feelings of wellbeing (Koepp et al., 1998).

The benefits of VR may also be enhanced by the duration of the intervention. This was apparent in two of the studies included in this review (Lin et al., 2020; Saladino et al., 2023), both studies offered an extended period of rehabilitation through VR. It is consistently documented that longer rehabilitation input is associated with improved outcomes (Bunyan et al., 2016), and virtual reality may offer a solution to do this without increasing inpatient length of stay through tele-neurorehabilitation. The benefits of this are apparent in Saladino et al. (2023), where the VR intervention had an extended remote-practice component for some participants after the initial intervention period. The results of the extended period were promising, indicating a further decrease in depression following the initial inpatient component. This emphasises the feasibility of VR neurorehabilitation interventions, demonstrating the practicality and adaptability for use in different settings if required.

Limitations and Future Directions

This review is not without limitations that warrant further consideration.

Firstly, the therapeutic use of VR is a continuously evolving field, with new approaches and technologies being implemented regularly. This review captures the applications and progress up to the search date (November 2023) potentially limiting the generalisability of the findings to future applications in this context. Similarly, the literature on this topic is still in a relatively early stage, meaning the availability of studies exploring mental health was somewhat narrow.

The review's scope and methodology may limit its generalisability. The findings show significant heterogeneity in the methods of applying VR across the studies included and in the populations studied, limiting comparability. However, there is a lack of evidence indicating which approach or methodology of applying VR is best in these settings. Future research should explore the impact of specific elements of VR (e.g., immersion, devices, exergaming), and should also focus on standardising or comparing methodology to determine which is most effective.

The review grouped studies based on the degree of immersion, excluding articles that had no immersive features. This may have increased the risk of bias due to the lack of consensus regarding what constitutes as immersive VR. However, precautions were taken to minimise this risk through the use of a peer reviewer who supported categorisation. Furthermore, there was a lack of standardisation of mental health measures across the included studies making it challenging to and limiting the review's ability to meaningfully highlight the impact it has on mental health. Also, the focus of the review was solely on measures of mental health and chose to exclude focus on other outcomes that may contribute to mental wellbeing such as QoL, pain,

and cognition. Doing so could mean the full extent of the impact of VR on mental wellbeing has not been sufficiently explored.

The findings provide insight into factors worthy of further exploration to improve the therapeutic use of VR in neurorehabilitation.

Conclusions

This review synthesised a growing body of literature outlining the use of VR in neurorehabilitation and the impact this has on the mental wellbeing of patients. Encouragingly, despite a high degree of heterogeneity in the applications of VR across the studies, current evidence for the use of VR in this setting is concordant with previous articles, in that VR interventions typically have a positive impact on mental health outcomes. Overall, it highlights that VR-based neurorehabilitation holds promise as a novel and engaging tool that can be used flexibly and successfully by multiple disciplines and with patients of varying morbidities and personal characteristics. It can be applied in a range of levels as an entire intervention or in adjunct to conventional therapies. Other key findings from this review include the importance of engagement, how certain features of VR may improve this, and the diversity of VR designs that should be utilised to tailor an intervention to best meet the patient's needs.

Additional research is required to determine what maximises positive mental health outcomes.

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Part Two

Empirical Paper

Enhancing self-compassion through virtual reality: Exploring the impact of personalisation and body satisfaction.

Abstract

Background

Immersive virtual reality (IVR) has emerged as a beneficial tool for interventions fostering self-compassion. Furthermore, research indicates that personalising avatars in VR can further enhance user experience in VR and potentially improve outcomes. This study expands on this by investigating the impact of avatar personalisation in a specific self-compassion IVR intervention. Furthermore, the study explores the potential moderating effect of body satisfaction when personalising avatars in this intervention.

Methods

50 subjects were recruited from a subject pool to participate in an IVR self-compassion intervention. Participants were randomly assigned to one of two conditions, a personalised avatar group and a non-personalised avatar group. Measures of self-compassion, self-criticism, VR experience and body satisfaction were completed prior to and following the intervention to explore change.

Results

Analyses revealed no significant interaction effect between avatar personalisation and the self-compassion intervention. However, the personalised group demonstrated a significant reduction in self-criticism and the non-personalised group demonstrated a significant improvement in self-compassion following the intervention. No significant differences in VR experience were found between the groups and controlling for body satisfaction had some influence on the model. The intervention also resulted in an improvement in body satisfaction.

Conclusions

This study highlights that regardless of avatar personalisation, the IVR intervention had positive effects on fostering compassion. However, embodying a personalised avatar resulted in a significant reduction in self-criticism scores that was not apparent in the non-personalised group. Furthermore, body satisfaction played a complex role which warrants further investigation to understand its influence. The results are discussed in relation to existing research, and several limitations were highlighted such as the limited sample size and representativeness. Directions for future research are also suggested.

Introduction

Self-compassion, a construct derived from Buddhist psychology which entails responding to oneself with empathy, warmth and connectedness (Neff, 2003b), is robustly associated with psychological wellbeing (Zessin et al., 2015). Self-compassion's contribution to a healthy inner environment is multi-faceted and according to Neff (2003a; 2003b), it has three core components. *Self-kindness* which entails approaching oneself with warmth and understanding when presented with distress, *common humanity* to recognise that failures and setbacks are part of a shared experience amongst people, and finally *mindfulness* which entails observing one's inner processes and being present in their environment rather than avoiding experiences. It has been proposed that being compassionate to oneself can cultivate emotional resilience and help buffer or reduce the peaks of emotions or self-criticisms resulting from negative experiences (Ferrari et al., 2018) and it can help to create a sense of inner safety and security (Neff, 2011) to support with emotional regulation.

Self-Compassion and Mental Wellbeing

The growing recognition of the link between self-compassion and mental wellbeing has resulted in the development and uptake of compassion-focused therapies. Compassion-focused therapy (CFT) is a form of psychotherapy that recognises that the mind can have a natural tendency to be self-critical and hold negativity bias (Gilbert, 2009). CFT teaches individuals to develop a more accepting and understanding view of themselves and others, particularly during times of adversity or in response to failure (Leaviss & Uttley, 2015), by developing compassion towards themselves, towards others, and from others. By fostering compassion, CFT proposes that individuals can reduce self-criticism, improve emotional regulation and improve self-esteem, improving overall mental wellbeing. The evidence base for CFT is vast

and highlights that it has an impact on improving mental wellbeing and mitigating mental health difficulties (Craig et al., 2020).

Fostering Compassion With Virtual Reality

In recent years, virtual reality (VR) has gained significant traction as a therapeutic tool, offering immersive and interactive experiences that can emulate real-world interactions. The literature on the use of immersive VR (IVR) in mental health is rapidly evolving, and its success has been documented in improving anxiety and depression (Jingili et al., 2023), treating phobias (Freeman et al., 2018), and in the management of symptoms related to schizophrenia (Pot-Kolder et al., 2018). Adding to this, research has demonstrated that VR can be successfully used as a platform to practice and improve self-compassion in the treatment of mental health difficulties by reducing self-criticism and cultivating kindness towards oneself (Falconer et al, 2014; 2016). In this research, Falconer and colleagues successfully created a virtual scenario using avatars to deliver imagery-based techniques that are commonly used in CFT. A single session of this paradigm resulted in improvements in self-criticism and self-compassion in a non-clinical sample (2014). Similar findings were reported in a longer-term intervention with a clinical sample (2016).

Enhancing Embodiment

Crucial to the design of Falconer's research was participants embodying an avatar. Embodiment is an important feature in creating a compelling and effective VR experience (Kilteni et al., 2012). It refers to the illusion of occupying a virtual body that the user owns and controls in a virtual world, rather than viewing it from a third-person perspective (Kilteni et al., 2015). There are three components of embodiment which are summarised succinctly by Gall et al., (2021). They include *presence,* which is the sensation of physically being in a virtual

world, *sense of agency* which is the sense of controlling the virtual body and its actions and the virtual body's actions matching the users, finally *sense of body ownership* refers to the illusion and sensation that the virtual body the user sees truly belongs to them.

Embodiment improves the immersion, interactivity and enjoyment of VR, which in turn are necessary to generate real-world experiences (Leveau & Camus, 2023). This is particularly important for some VR therapies and simulations, where the aim is to ensure that the skills practised are generalisable and can be applied in real life, for example in anxiety disorders and exposure therapy (Morina et al., 2015; Opris et al., 2012). Research has demonstrated that avatar characteristics can influence self-perception and embodiment in VR (Halbhuber et al., 2023). This prompts the question of how to best customise avatar characteristics in VR interventions to optimise user experience and maximise a sense of embodiment. Avatar realism is highlighted as an important factor, Roth et al. (2016) found that social interactions in VR can be impeded when non-realistic avatars are used. Considering the potential influence of the proteus effect may also be beneficial when understanding the role of avatar appearance. The proteus effect posits that the traits of a virtual representation can affect a user's experience in both virtual and real-world environments (Yee & Bailenson, 2007; Yee et al., 2009). For example, avatars that are deemed more physically attractive were rated as having higher social competence (Merola & Pe, 2009).

Avatar Personalisation

Specifically, the literature emphasises that avatar personalisation – creating an avatar that is based on the physical characteristics of the user, has a positive impact on the VR experience. Waltemate et al. (2018) found that embodiment, body ownership and immersion are positively impacted when personalised avatars are used. Furthering this, Radiah et al. (2023) explored

this effect in relation to gender-matching and found that the effect of avatar personalisation is only present when the avatar matches the gender of the user. In the same study, Radiah and colleagues also found that personalisation positively impacts emotion elicitation.

Given these promising findings regarding avatar personalisation, building upon the work of Falconer and colleagues to include personalised avatars in the self-compassion IVR intervention would be beneficial. The findings highlight prospects for increased engagement and self-presence if users have an avatar that resembles them rather than the generic avatars used previously. The potential for increased immersion and self-presence could translate to a stronger transfer of the IVR intervention's effects to real-world situations. However, while personalisation holds promise, it's crucial to consider individuals practising self-compassion using IVR with negative self-perceptions or who are critical of their body image.

The Impact of Body Dissatisfaction and The Power of Self-Compassion

Body image is a multi-faceted construct representing an interplay between thoughts, beliefs, emotions and behaviour (Cash, 2004). Body dissatisfaction can be defined as holding negative perceptions about one's body, including one's size, shape, and physical features (Cash & Smolak, 2011). Self-discrepancy theory (Higgins, 1987) posits that body dissatisfaction stems from a discrepancy between one's actual body image and their ideal body image. Like self-compassion, body satisfaction is also closely associated with psychological wellbeing (Forman & Davis, 2005; Tylka, 2004). Research conducted with a sample of 4,505 adults in the United Kingdom highlighted that within the year of completing the study, 20% felt shame about their body, 34% felt that it impacted their mood, and 19% reported experiencing feelings of disgust in relation to their body (Mental Health Foundation, 2019). Furthermore, it is widely evidenced that body dissatisfaction is associated with a higher risk of developing eating disorder

symptomology (Rosewall et al., 2019), as well as mental health difficulties such as anxiety and depression (Barnes et al., 2020), lower quality of life (Mond et al., 2013) and suicidal ideation (Kim & Kim, 2009). Thus, emphasising the need to prioritise research and develop interventions that support with body dissatisfaction.

There is a compelling evidence base to support the success of interventions that encompass self-compassion for improving body satisfaction. A study by Moffitt et al. (2018) highlighted the success of an intervention that was centred around cultivating self-compassion to improve trait body dissatisfaction compared to a control group. These findings are consistent with other studies, Albertson et al. (2014) found that women who engaged in daily meditations focused on self-compassion had a greater decrease in body dissatisfaction compared to women on the waiting list. Additionally, following a letter-writing self-compassion exercise, Nightingale and Cassin (2023) reported participants had more self-compassion and a more adaptive body image. These examples employed a range of techniques to foster self-compassion effectively demonstrating its versatility and transferability as an intervention for body dissatisfaction.

Furthermore, considering the evolving interest in VR as a therapeutic tool, and the benefits of self-compassion for improving body satisfaction, interventions such as that demonstrated by Falconer et al. (2014; 2016) warrant further exploration. Specifically, it would be helpful to understand how self-compassion outcomes are impacted by levels of body satisfaction when virtual representations are personalised. Findings from Kim and Sundar (2012) highlight that personalising avatars can result in a heightened awareness of the user's mental image of their bodies and can affect health behaviour outcomes. Personalising the physique of avatars has also been found to increase body image discrepancy and result in reductions in body image

satisfaction (Park, 2018). which may counteract the benefits of personalisation noted in existing literature.

Aims

Therefore, this study aims to build upon previous research by Falconer et al. (2014; 2016) which evidenced the effectiveness of IVR interventions in fostering self-compassion and reducing self-criticism using non-personalised avatars. This study aims to determine if the personalisation of avatars to share physical similarities with the user impacts their experience of practising and receiving compassion, and if this is likely to be influenced by their satisfaction with their body. Therefore, the proposed hypotheses are as follows;

1. There will be a significantly greater change in self-compassion and self-criticism scores between the participants assigned to the personalised avatar condition vs the non-personalised condition following the IVR intervention.

2. Participants assigned to the personalised avatar condition of the IVR intervention will have a significantly stronger VR experience (e.g. their presence in the IVR and avatar embodiment experience) than those assigned to the non-personalised avatar condition, as measured by the VR experience questionnaire.

3. Body satisfaction will account for some of the variances in the difference in self-compassion and self-criticism scores between the participants in personalised and non-personalised avatar groups following the IVR intervention.

Methods

Design and Participants

The study used an experimental design exploring the impact of avatar personalisation on a single-session IVR self-compassion intervention. Variables of interest (self-compassion, self-criticism) were compared over time (prior to the intervention and directly following the intervention). The between-participants variable was the avatar group, there were two conditions to which participants were randomly allocated– personalised avatars (condition 1) and non-personalised avatars (condition 2). The dependent variables in the study were self-compassion and self-criticism scores, VR experience and body-image satisfaction, which was explored as a covariate. This study formed part of a joint project, further details and roles are outlined in Appendix A.

Participants were recruited using a university subject pool (Sona) facilitated by the psychology division for both students and members of the general population. The benefits of using this method included access to a diverse range of participants. Participants applied using the subject pool portal and were screened for eligibility based on the following criteria; 1). Applicants should be over the age of 18; 2). They should have fluency in reading and speaking English; 3). They should not have a neurological condition such as epilepsy or a condition that would mean they would experience adverse effects from the IVR (e.g. motion sickness). Participants were excluded from the screening process if they failed to meet this criteria, or if they were receiving treatment for a diagnosed mental health condition at the time of the study. Participants who met the inclusion criteria were randomised to one of the two groups using a computer programme, due to the nature of the study it was not possible to blind experimenters or participants to their assigned conditions. Participants were sent materials relevant to their groups, those that did not complete these materials in advance of the study were also excluded.

As this study partially replicated Falconer et al. (2014), power calculations from Falconer's work informed this study. It was indicated that 18 subjects per group were sufficient to assess the difference in compassion scores between groups with a large effect size (Cohen's f = 0.35, alpha = 0.025, beta = 0.2). Thus, the researcher proposed to recruit 50 subjects in total (25 per group) to allow for error and possible attrition.

Measures

A questionnaire was sent to each of the participants before attending the in-person IVR session. The questionnaire collected demographic data such as age, ethnicity, and sex, and included the measures outlined below.

The Self-Compassion and Self-Criticism Scale (SCCS) (Falconer et al., 2014) – This scale was applied in previous studies by Falconer et al. (2014;2016) to measure state compassion and self-criticism. The questionnaire consists of five scenarios designed to elicit varying levels of self-compassion or self-criticism. Participants are asked to imagine the scenario happening to them, and to rate using a 7-point Likert scale, how they would react to themselves in that scenario. Participants completed this measure both prior to the intervention and directly after. The SCCS has demonstrated high internal validity (Cronbach's alpha ≥ .87) in the validation study.

Multidimensional Body-Self Relations Questionnaire – Appearance Scales (MBSRQ-AS) (Cash, 2000) – the appearance evaluation (AE) and body areas satisfaction scale (BASS) of the 34-item MBSRQ were used to evaluate body satisfaction. The scale uses a five-point Likert scale to measure the degree of body satisfaction/dissatisfaction. Higher scores on both the AE and the BASS indicate greater levels of appearance evaluation and satisfaction. A systematic review by Kling et al. (2019) indicated that all studies reporting Cronbach's alphas for the AE and BASS found good internal consistency for these subscales (≥ .70), except one study by

Untas et al (2009) which reported a Cronbach's alpha of .66 in a French adaptation of the BASS. Participants completed this measure both before the intervention and directly after.

Virtual Reality Experience Questionnaire (Falconer et al., 2014) – Falconer's previous studies (2014; 2016) used this scale to explore participants' experience of the IVR, including their experience of body ownership, the virtual environment, and to determine if there were differences between the personalised avatar group and the non-personalised avatar group. Participants completed this questionnaire following the IVR intervention.

Virtual Environment

The virtual environment was facilitated using an Oculus Quest headset (Meta Platforms Inc.) and delivered software developed by Virtual Bodyworks S.L., Barcelona, specifically for this paradigm. Avatars were created using Character Creator 3 (Reallusion Inc.). Generic avatars were created using the Racially Diverse Affective Expression (RADIATE) stimulus set (Conley et al., 2018).

Ethics Statement

The protocol was previously approved through the Ethics Committee of the University College London Division of Psychology and Language Sciences as part of an ongoing wider study (Barrington, 2022) (Appendix B). Written informed consent was attained from all participants. All participants were given an inconvenience reimbursement of either £10 or the option of course credits for students.

Procedures

Following the screening process and completion of consent forms (Appendix D), eligible participants were emailed a link to the questionnaire to be completed before attending the in-person session. Participants were also informed which group they had been allocated to.

Participants in the personalised avatar group were asked to send researchers a passport-style photograph of themselves for the purpose of making the avatar and to select a body shape that they felt best represented their body. Participants in the non-personalised group were asked to choose from a pool of 10 generic avatars based on the RADIATE stimulus set.

Following the successful completion of the above questionnaire and receipt of consent forms, participants were then invited to an in-person session to complete the IVR intervention. The intervention was a single-session exercise aimed at improving knowledge about compassion, and to practice delivering and receiving compassion with an avatar. They were presented with a brief video that introduced the idea of self-compassion and self-criticism (Appendix F) followed by a script based on prior work in the lab (Barrington, 2022) containing statements relating to self-compassion (validation, redirection of attention and memory activation) (Appendix G). They were asked to practice delivering these statements compassionately with the researcher and to memorise these statements to the best of their ability ahead of the IVR exercise.

Once the participants felt comfortable delivering these statements they were fitted with the VR headset which was pre-loaded with either a personalised avatar or a generic non-personalised avatar. Participants then engaged in a simple embodiment exercise lasting approximately two minutes to ensure the avatar moved in synchrony with their movements (visual-motor synchrony). The 3D environment simulated a neutral therapy room, the participants' avatars were sitting directly in front of a mirror, meaning participants could see their avatars moving and talking in synchrony with their bodies. The next phase required participants to interact with a virtual child which was placed in front of them next to the mirror. The child avatar appears visibly upset but was programmed to respond positively and appear soothed to the participant

following the delivery of each of the compassionate statements that were memorised prior. This phase of the study involved the participant practising delivering compassion.

The subsequent phase consisted of the participant experiencing the compassionate statements from a new perspective, as the child avatar. Firstly, the participant swapped into a new virtual body, embodying the child, which was apparent from the mirror placed in front of them and they completed another short embodiment exercise. Next to the mirror was the original avatar. Participants then re-experienced the compassionate statements from a real-time recorded replay of what they had previously said to soothe the child, but now from the child's perspective. The participants were asked to simply sit and observe the compassionate statements that they could hear. Finally, participants removed the HMD exiting the virtual reality, and then completed the post-intervention questionnaire.

Figure One.

Example of Embodied Personalised Avatar Interacting With The Child Avatar.

Figure Two.

Example of Embodiment of The Child Avatar Following The Body Swap.

Data Management and Analysis

Participant demographics and questionnaire data were stored on a secure, password-protected spreadsheet. Participants were provided with ID numbers which they used to complete the questionnaire, thus all data was anonymised and untraceable to the participant. The data was formatted and uploaded to JASP (JASP Team, 2024) a statistical analysis programme, to complete the analyses.

For hypothesis one, the proposed analysis is a mixed-model repeated measures ANOVA to examine the effects of the difference in personalised and non-personalised groups, over time, on self-compassion and self-criticism. For hypothesis two, the proposed analysis is an independent t-test, to compare VR experience scores between the personalised and non-personalised avatar groups. Finally, an ANCOVA will be conducted to examine the effects of

personalized and non-personalized avatars on self-compassion and self-criticism while controlling for body satisfaction.

A number of the variables violated assumptions of normality (Appendix H), these included the MBSRQ-AE and BASS in the personalised group, the SCCS self-compassion in the non-personalised group and two items of the VR experience questionnaire for the personalised and non-personalised group.

Results

50 participants were recruited for the study, and 25 were randomly allocated to each group. All 50 participants successfully completed all components of the intervention. Participant characteristics and baseline scores on dependent variables are outlined in Table One.

Table One.

Participant Characteristics and Baseline Group Differences.

Participant Characteristic	Personalised	Non-Personalised	Significance
Gender	*Freq.*	*Freq.*	
Male	6	3	X^2 (1, N = 50) = 8.9, p = .27
Female	19	22	
Age	*Mean (SD)*	*Mean (SD)*	
	29.8 (11.98)	23.7 (8.5)	U = 422.5, p = .033*
	Range: 18 - 60	Range: 18 - 59	
Ethnicity	*Freq.*	*Freq.*	
Asian / Asian British	10	17	
White / Caucasian / White British	9	6	
South Asian / Asian British	1	1	
Black / Black British	1	0	X^2 (6, N = 50) = 6.4, p = .38
Middle Eastern / North African	1	1	
Latinx / Hispanic	1	0	
Mixed Ethnicity – White & Asian	2	0	
SCCS	*Mean (SD)*	*Mean (SD)*	
Self-Compassion	40.00 (18.05)	31.16 (15.67)	U = 406.5, p = .069
Self-Criticism	58.96 (18.64)	53.40 (17.12)	t(48) = 1.09, p = .29
MBSRQ - Subscales	*Mean (SD)*	*Mean (SD)*	
Appearance Evaluation (AE)	22.08 (5.66)	23.60 (5.8)	U = 259.5, p = .305
Body Areas Satisfaction (BASS)	0.56 (6.06)	29.88 (6.33)	t(48) = .388, p = .70

*Denotes statistically significant findings

Differences Between Groups at Baseline

Independent sample t-tests and Mann-Whitney U tests demonstrated that other than participant age, the characteristics and baseline dependent variable measures were not significantly different between the personalised and non-personalised groups. Table One and Table Two outline statistical findings from the outcome variables.

Table Two.

Mean (SD) of Measures, Pre and Post by Avatar Group.

Measure	Personalised		Non-Personalised	
	Pre	Post	Pre	Post
SCCS				
Self-Compassion	40.00 (18.05)	45.68 (18.85)	31.16 (15.67)	38.56 (19.22)
Self-Criticism	58.96 (18.64)	51.64 (18.7)	53.40 (17.12)	51.08 (15.84)
MBSRQ - Subscales				
Appearance Evaluation (AE)	22.08 (5.66)	23.68 (4.75)	23.60 (5.8)	23.68 (3.56)
Body Areas Satisfaction (BASS)	30.56 (6.06)	30.80 (6.51)	29.88 (6.33)	30.88 (5.36)
VR Experience				
Presence		0.16 (1.68)		0.72 (1.62)
Adult Body Ownership & Agency		-0.16 (3.46)		1.12 (2.92)
Child Body Ownership & Agency		-1.92 (3.07)		-0.84 (3.33)
Child Recognises Adult as Self		-0.56 (4.52)		-0.64 (3.77)
Child Sense of Being Comforted		-0.44 (4.63)		0.48 (3.81)

Personalisation and SCCS Scores

Repeated measures ANOVAs were performed to determine if the IVR intervention's effect on self-compassion and self-criticism differed significantly between the personalised and non-personalised groups. The findings should be interpreted with caution as normality assumptions were not met for the self-compassion variable in the non-personalised group. While non-parametric tests such as the Friedman test were initially considered, the data did not meet the

necessary assumptions. Therefore, a mixed-model repeated measures ANOVA was employed to analyse the effects of the intervention.

There was insufficient evidence to support a significant interaction effect between time (pre-post intervention) and avatar group on self-compassion $F(1, 48) = 0.27$, $p = .60$, $\eta_p^2 = .006$. However, there was a significant main effect for time alone $F(1, 48) = 15.76$, $p < .001$, $\eta_p^2 = .247$. To identify which groups differed on self-compassion, Holm's sequential Bonferroni correction was utilised to account for multiple comparisons, this indicated that the non-personalised group had a significant improvement in self-compassion following the intervention $p = .016$. This post-hoc test should be interpreted with caution due to issues with normality in the non-personalised group's self-compassion scores.

There was insufficient evidence to support the presence of a significant interaction effect between time and avatar group on self-criticism $F(1, 48) = 2.54$, $p = .117$, $\eta_p^2 = .005$. However, there was a significant main effect for time alone, $F(1, 48) = 9.45$, $p = .003$, $\eta_p^2 = .019$. Holm's sequential Bonferroni correction was performed to conduct multiple comparisons following the significant main effect, this indicated that the personalised group had a significant improvement in self-criticism following the intervention $p = .011$.

The findings partially support the alternative hypothesis as there were significant differences in outcomes between the personalised and non-personalised groups. However, this was not supported by a significant interaction effect.

Figure Three.

Descriptive Plots Outlining Changes in Self-Compassion Scores.

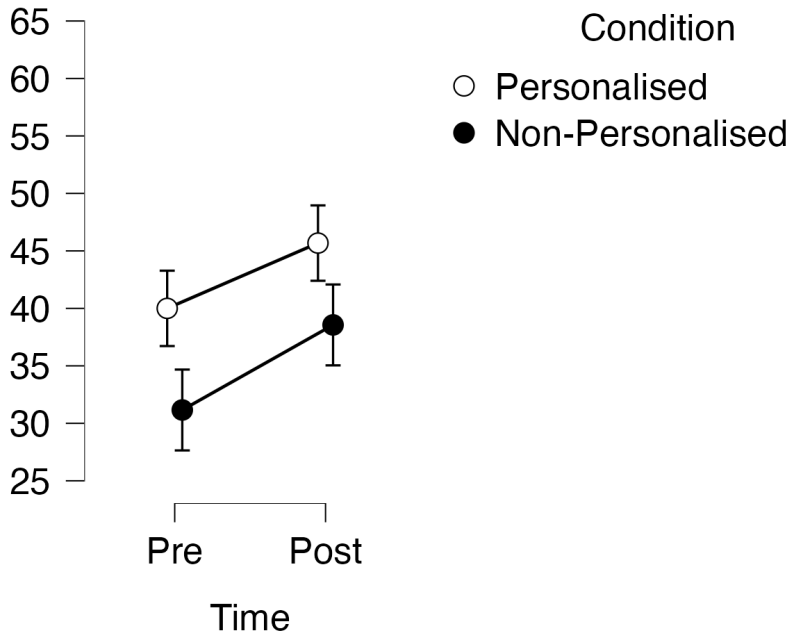
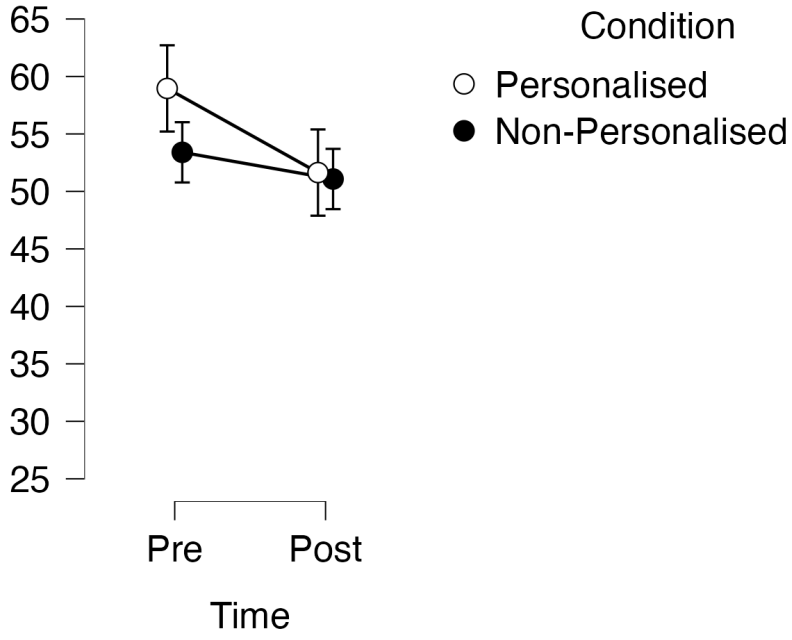


Figure Four.

Descriptive Plot Outlining Changes in Self-Criticism Scores.



Personalisation and VR Experience

Independent t-test analyses were conducted to determine if there was a difference in VR experience between the personalised and non-personalised avatar groups.

There were some normality issues apparent when testing this variable (see Appendix H), thus for variables where normality was violated Mann-Whitney U tests were reported. However, there were no significant differences between the personalised and non-personalised avatar group for IVR the experience of presence, adult body ownership and agency, child body ownership and agency, the child recognising the adult as themselves, and the child's sense of being comforted.

Thus there is insufficient evidence to reject the null hypothesis.

Table Three.

Comparison of Personalised and Non-Personalised Groups on VR Experience.

VR Experience Domain	t-test statistic
Presence	U = 243.0, p = .165, *rbs* = -0.222
Adult Body Ownership & Agency	t(48) = -1.41, p = .164, d = -0.400
Child Body Ownership & Agency	t(48) = -1.19, p = .238, d = -0.338
Child Recognises Adult as Self	U = 330.0, p = .740, *rbs* = .056
Child Sense of Being Comforted	t(48) = -0.77, p = .447, d = -0.217

* denotes reporting of Mann-Whitney U test due to violations of normality.
'rbs'denotes Rank Biserial Correlation for Mann-Whitney U effect size.

Personalisation, SCSS & Body Satisfaction MBSRQ-AE MBSRQ-BASS

An analysis of covariance was performed to explore if participants' body satisfaction accounts for any of the variance in self-compassion and self-criticism scores in the model, and if this differed between the avatar groups. AE and BASS change variables were created and inputted as covariates in the repeated measure ANOVAs performed prior, which previously highlighted that the personalised group had a significant improvement in self-criticism and the non-personalised group had a significant improvement in self-compassion following the intervention, however, there were no significant interaction effects. Again, these findings should be interpreted with caution owing to the AE and BASS change scores of the personalised group deviating from normal distribution.

For self-criticism, the analysis revealed that the interaction between time (pre-post intervention) and change in AE $F(1, 46) = .804$, $p = .375$, $\eta_p^2 = .017$ as well as time and change in BASS $F(1, 46) = .270$, $p = .606$, $\eta_p^2 = .006$ were non-significant. The effect of the intervention on self-criticism is not influenced by changes in AE and BASS. The main effect of time on self-criticism when controlling for AE and BASS was statistically significant $F(1, 46) = 6.98$, $p = .011$, $\eta_p^2 = .132$. Indicating that self-criticism scores significantly change following the intervention regardless of changes in AE and BASS throughout

Additionally, the effect of change in AE $F(1, 46) = 2.38$, $p = .130$, $\eta_p^2 = .049$ and change in BASS $F(1, 46) = 3.403$, $p = .072$, $\eta_p^2 = .069$ on self-criticism did not significantly differ between the personalised and non-personalised groups. This highlights that changes in AE and BASS across the groups do not contribute differently to changes in self-criticism in the intervention.

For self-compassion, the analysis revealed that the interaction between time and change in AE $F(1, 46) = .140$, $p = .710$, $\eta_p^2 = .003$ as well as time and change in BASS $F(1, 46) = .113$, $p = .738$, $\eta_p^2 = .002$ were non-significant. Indicating the effect of the intervention on self-compassion is not influenced by changes in AE and BASS. When controlling for AE and BASS, the main effects of time on self-compassion was statistically significant $F(1, 46) = 13.550$, $p < .001$, $\eta_p^2 = .228$ indicating that self-compassion scores significantly change following the intervention regardless of changes in AE and BASS.

Similarly, the effect of change in AE $F(1, 46) = 2.222$, $p = .143$, $\eta_p^2 = .046$ and BASS $F(1, 46) = .280$, $p = .599$, $\eta_p^2 = .006$ on self-compassion did not significantly differ between the avatar groups. Indicating that changes in AE and BASS across the avatar groups do not contribute to changes in self-compassion scores in the intervention. However, when controlling for changes in AE and BASS, the between-subject factor avatar group becomes significant $F(1, 46) = 4.322$, $p = .043$, $\eta_p^2 = .086$ indicating that the avatar group has a unique effect on self-compassion that is not explained by changes in AE and BASS alone.

These findings partially support the alternative hypothesis, that body satisfaction accounts for some of the variance in self-compassion scores. When controlling for body satisfaction changes in self-compassion following the intervention become significant.

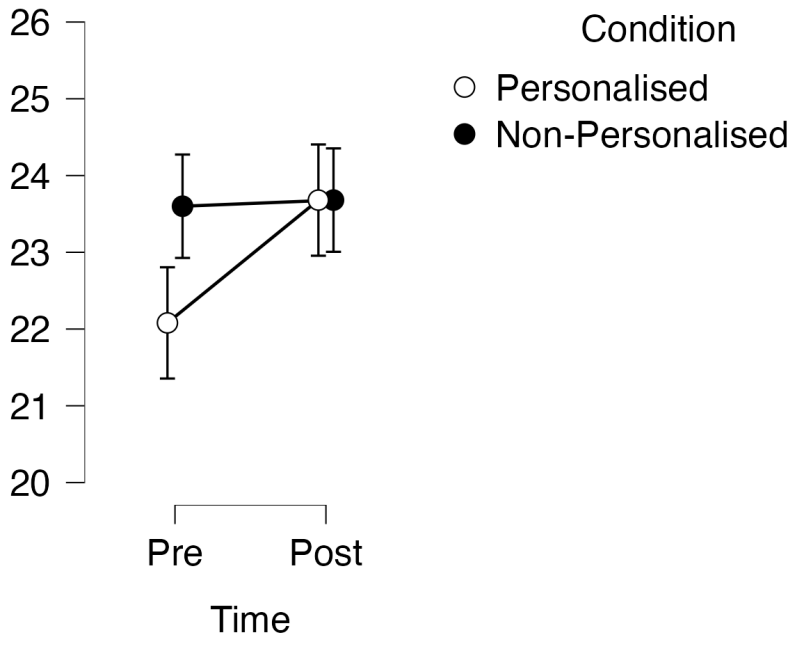
Additional Findings

The general impact of the intervention was analysed using the Wilcoxon signed-rank test, due to issues relating to normality. The results indicate a significant improvement in both self-compassion, $t = 200.000$, $p < .001$, $z = -3.584$ and self-criticism $t = 891.500$, $p < .002$, $z = 3.11$ following the IVR intervention, irrespective of the avatar group.

A repeated measures ANOVA indicates a significant interaction effect between time and avatar group on appearance evaluation (AE subscale of the MBSRQ) $F(1, 48) = 5.03$, $p = .030$, $\eta_p^2 = .095$ as well as a significant main effect of time on AE $F(1, 48) = 6.14$, $p = .017$, $\eta_p^2 = .113$. This indicates that the avatar group influences how body satisfaction changes from the intervention. Examination of simple main effects indicates that within the personalised avatar group appearance evaluation significantly improved $F(1, 48) = 10.38$, $p = .004$.

Figure Five.

Descriptive Plot Outlining The Change in AE Scores of Personalised and Non-Personalised Groups.



However, there was no significant interaction $F(1, 48) = 1.024$, $p = .317$, $\eta_p^2 = .021$ effect between time and avatar group on body areas satisfaction or (BASS subscale of the MBSRQ), as well as no significant between-subject or within-subject main effects main effects $F(1, 48) = 2.725$, $p = .105$, $\eta_p^2 = .054$.

Discussion

Overall, this intervention had some positive effects on healthy participants, evidenced by a significant increase in self-compassion scores, a reduction in self-criticism scores, and an improvement in appearance evaluation. These effects were present regardless of avatar personalisation, not only demonstrating the utility of the intervention but also strengthening and validating previous versions of this intervention, which report findings consistent with those of this study (Falconer et al., 2014; 2016). Falconer's 2016 study differed as they used a clinical sample of people with depression, which is associated with higher self-criticism. This was apparent when comparing the mean self-criticism scores of Falconer's study with that of this study which used a healthy sample [67.23 vs 56.18]. However, following the intervention mean self-criticism scores were similar to this study [49.54 vs 51.36]. Falconer's study was also longer in duration. Cognitive theory posits that a key maintaining feature of depression is rigid thinking (Beck, 1964), cognitive based therapies target these beliefs however this takes time, therefore it is understandable why a longer intervention was required to see a significant change in Falconer's study. Falconer et al. also included a 4-week follow-up score that reported further reductions in self-criticism. Comparing these findings with existing research demonstrates that a single session of the intervention is effective in a healthy sample, however, it is possible that further improvements in outcomes would be apparent with the measurement at a later time point, as the full impact of the self-compassion skills practised may not be apparent directly after the intervention.

The Impact of Avatar Personalisation

A specific feature of this study was the personalisation of the avatars embodied to practice self-compassion. The findings indicate a potential influence of avatar personalisation on user outcome, as there was some variation between the personalised and non-personalised groups.

Although not supported by a significant interaction effect, significant main effects indicate that self-criticism and self-compassion outcomes differed following the intervention for the two conditions.

The personalised avatar group demonstrated a significant reduction in self-criticism scores following the intervention. These findings are promising, as self-criticism is often associated with lower self-compassion. While the intervention did not directly increase self-compassion for the personalised group it may have targeted a related issue, negative self-evaluation. Examination of the distribution plots (Figure Four) portrays a similar trend for the non-personalised group, however, this was non-significant, perhaps owing to insufficient power.

A similar trend was apparent in the non-personalised group. Although no significant interaction effects were found, a significant improvement in self-compassion was identified that was not apparent in the personalised group. This highlights the potential effectiveness of the intervention without the added need for personalisation. As above, examination of the distribution plots (Figure Three) reveals that a similar trend of improvements occurred in the personalised group, however, this was non-significant, again perhaps due to limitations in statistical power.

The findings may be influenced by existing differences between the groups at the study's baseline. Descriptive plots highlight that the personalised group had an elevated self-criticism score prior to the intervention, yet a similar mean score to the non-personalised group after the intervention. Baseline statistics (Table One) did not find a significant difference in self-criticism scores between the groups, however, it is possible that this higher baseline score in the personalised group resulted in a higher magnitude of change in self-criticism. Similarly,

the plots indicate that the personalised group had higher baseline self-compassion scores, albeit not significantly different to the non-personalised group. Nevertheless, it is possible that this higher baseline resulted in a smaller magnitude of change.

A significant age difference between the groups was identified, with the personalised group having a greater mean age [M = 29.8 vs 23.7]. Previous research evidences that with increasing age, people tend to hold a greater ability to be self-compassionate (Homan, 2016; Hwang et al., 2016), which may account for the elevated baseline self-compassion scores in the personalised group. Additionally, the nature of the study meant that participants could not be blinded to their condition, potentially introducing a confounding factor. Systematic differences in the conditions, namely the personalised group being required to take and send a photograph to the researchers and select an avatar physique that represented their own, may have impacted self-compassion and self-criticism baseline scores for the group. As highlighted, self-resembling avatars can make salient mental images of one's body (Kim & Sundar, 2012). This could potentially explain the elevated self-criticism scores for the personalised group, as participants completed their baseline measures at the same time that they sent their photograph and selected their avatar body.

Furthermore, fears of compassion may be a contributing factor to these findings. CFT research emphasises that compassion has three 'flows', and fears in these flows can inhibit an individual's ability to practice compassion, these include; 1. *Fear of self-compassion*; 2. *Fear of compassion from others*; 3. *Fear of compassion to others* (Gilbert et al., 2011). People can find it difficult to experience the different aspects of compassion, for example, some may find it easier to be compassionate to others than themselves (Kirby et al., 2019; Best et al., 2021). It is possible that personalised avatars, while intended to improve immersion and engagement,

inadvertently triggered a fear of compassion as a result of seeing a virtual representation of themselves, that was not experienced by the non-personalised group.

Despite these variations in compassion and criticism outcomes between the avatar groups, the findings do not suggest that this is a consequence of the IVR experience, such as the level of embodiment and sense of ownership. Firstly, compared to Falconer's study (2016), observations of the means and standard deviations indicate the responses in the study were more dispersed, indicating a greater variability of responses, possibly owing to the added factor of personalisation. Secondly, the personalisation of the avatar did not significantly impact the specific features of the VR experience. These results diverge from previous literature, which found that VR interventions that use avatars based on the user's facial appearance and physical features resulted in significantly greater levels of embodiment and presence (Suk & Laine, 2023). A potential explanation for these findings may be that the level of personalisation of avatars was not robust enough to elicit a strong enough differential effect between the personalised and non-personalised groups. This intervention used the same VR technology and software as Falconer's previous studies (2014; 2016). While functionally equivalent, the field has undergone advancements in recent years, for example recently artificial intelligence has been able to create highly realistic scenarios and video simulations including humans that are almost indistinguishable from reality. Therefore, it is possible that participants' expectations of the extent of personalisation and realism of avatars may not have aligned with what was presented to them. This may have influenced VR experience domains such as sense of embodiment, presence and body ownership.

The Role of Body Satisfaction

Owing to previous literature highlighting negative effects on body image following personalisation (Park, 2018) it was anticipated that body satisfaction may influence the intervention's effectiveness particularly when personalised avatars are used. The findings revealed that self-compassion and self-criticism improved regardless of the avatar group following the intervention despite controlling for body satisfaction. The findings also revealed that when body satisfaction is controlled for, the avatar group has a significant impact on self-compassion outcomes that wasn't apparent before controlling for body satisfaction. It is possible that a suppression effect occurred, and by controlling for body satisfaction the true impact of avatar condition was apparent.

The findings may also be explained by other incidental findings in this study. The results highlighted that this IVR self-compassion intervention improved appearance evaluation for the personalised avatar group. It is possible that body satisfaction levels have a mediating effect on self-compassion and self-criticism outcomes and indirectly affect these outcomes through improvements in body satisfaction, particularly when using personalised avatars. Alternatively, personalised avatars may specifically target body satisfaction. This warrants further investigation to investigate these specific mechanisms. Nevertheless, the intervention builds on existing research demonstrating the effectiveness of interventions incorporating self-compassion for improving body satisfaction (Toole et al., 2021) and may indicate that there is scope for IVR-based compassion interventions for body image concerns.

Limitations and Implications For Future Research

This study was not without its limitations. Firstly, the recruitment methods may have limited the generalisability of the study. The recruitment strategy employed a subject pool which was

affiliated with the university, although individuals who were not students also had access to the pool. Consequentially, the sample yielded a high representation of university students, specifically international students, which may not be representative of the non-university population. Lacking representation in the study were individuals from Black/Black British, South Asian/South Asian British, Middle Eastern/ North African and Latinx/Hispanic ethnicities.

Additionally, there was a higher representation of females than males, which may have impacted the scores and generalisability of these results. A meta-analysis by Yarnell et al. (2015) found that males typically have higher levels of self-compassion. It is possible that if this study was replicated with more males included, self-compassion scores may have been greater. Should this study be replicated, the recruitment methods should be broadened to increase the diversity of participants from being predominantly a university student population. The sample size was also relatively small which may have impacted the ability to detect a meaningful effect. Future studies should employ a greater sample size to increase statistical power.

Furthermore, the manipulation of avatars may have introduced some procedural bias and affected the participants' experience of the intervention. Having an intervention that is more personalised to the participant may have impacted their engagement, their sense of ownership, and may have introduced social desirability bias. The nature of the intervention means that it would be difficult to eliminate this as avatars cannot be blinded from participants, however completing pre-intervention measures before allocation to an avatar condition, or blinding all participants until they start the intervention, may reduce some bias.

It is possible that the psychoeducation video used to introduce compassion in the intervention and previous versions of this study (Falconer et al., 2014; 2016; Barrington, 2022) it impacted the internal validity of the study. The content of the video may have contributed to changes in self-compassion and self-criticism. Future studies may wish to control for this by comparing a control group that receives the video psychoeducation without the IVR intervention, allowing for a more direct comparison of the effects of the IVR intervention.

The findings indicate that regardless of personalisation, the IVR intervention was effective at improving self-compassion and self-criticism. Creating personalised avatars and ensuring they are robust requires a time investment that clinicians often don't have. The findings in this study indicate that clinicians may not need to go the lengths of personalising avatars to see improved outcomes.

The study also highlights incidental findings which may have future implications for body satisfaction research. Future research may wish to focus more specifically on body satisfaction as a mediator in this intervention to better understand the underlying mechanisms on avatar personalisation and the impact on self-compassion scores. Additionally, future studies may wish to tailor the intervention and avatars to incorporate features that address body image concerns.

Conclusions

This research investigated the personalisation of avatars in an IVR self-compassion intervention. The findings suggest that personalisation has some impact on improving self-criticism scores, whereas greater improvements in self-compassion outcomes were apparent in the non-personalised group. However, this cannot be explained by group differences in their experiences of body ownership, agency of the avatar, and their sense of presence during the intervention. Regardless of personalisation, the intervention had positive effects.

Accounting for body satisfaction also provides a more nuanced understanding of these findings. The results suggest that when body satisfaction is controlled for, the avatar group has a significant impact on self-compassion outcomes, that was not previously apparent. Additionally, body satisfaction improved in this intervention for the personalised avatar group, overall indicating a possible mediating effect of body satisfaction when personalising avatars that warrant further investigation.

These results contribute to a growing body of research around the potential of personalised self-representations in digital interventions. Future research may wish to delve further into the underlying mechanisms of body satisfaction as a covariate. Additionally, as technology continues to evolve future research could explore methods to enhance the personalisation process to make it less time-demanding for researchers or clinicians and to improve the user's experience of the core VR features (immersion, embodiment, agency and ownership).

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Part Three

Critical Appraisal

Introduction

This critical appraisal will reflect on the key decisions and learning experiences that shaped both the systematic review and empirical study I conducted. Firstly, I will provide background as to the reasoning behind the systematic review topic. Furthermore, I will critically reflect on the methodologies and decision-making process of the empirical study. Specifically, I will focus on dilemmas that arose when personalising avatars and recruiting participants. Finally, this appraisal will highlight key learning outcomes and insights I have gained from completing this thesis, allowing for examination of my learning journey.

Systematic Review: Setting the Scene

During the initial stages of research design, I was faced with the decision between writing a conceptual introduction based on my empirical study topic or conducting a review of a related field. One of my clinical placements in neurorehabilitation was pivotal in finalising this decision.

During this placement, I witnessed first-hand the limitations of many traditional therapeutic approaches in clinical psychology for people who had neurological injury or disease. This was particularly evident in patients who had reduced ability to mobilise or verbalise. Indeed, as clinicians we can adapt our methods to be more accessible, however, I experienced instances where the scope of traditional psychological interventions felt restricted in their ability to meet patients' individual needs. As my placement progressed, I observed that the patients valued engaging and creative approaches to their therapy, for example, a bespoke rehabilitation treadmill, and using the Wii to practice upper limb movements. This sparked my interest in exploring alternative approaches to therapy that leverage technology.

Ultimately, this led to my decision to further research and understand how VR can be used to positively impact wellbeing within this population.

Facilitating Personalisation

One of the main dilemmas faced when developing the empirical project was creating a logical process map for creating the avatars. Initially, my co-researcher and I hoped for participants to be heavily involved with the avatar creation process and planned for them to accompany us while they were being made. Tinmaz & Dhillon (2024) investigated user engagement in avatar design, their research outlines the benefits of participant-designed avatars, such as enhanced engagement. In this study, we hoped that it could instil a sense of control and foster greater ownership of their avatar, leading to a more engaging and personalised experience. Additionally, I hoped it would help ensure we captured features that were important to the participant and that they strongly identify with, for example, having freckles or their hair being worn in a specific way.

As I familiarised myself with body image research, I came to understand self-discrepancy theory. This posits that body dissatisfaction forms when there is a discrepancy between the person's ideal self and their actual self (Higgins, 1987). Trepte and Reinecke (2010) found that when creating avatars, participants who were satisfied with their lives created avatars that closely resembled them, whereas those with higher levels of dissatisfaction resembled their avatars less. With this in mind, there was a concern that participants might create overly idealised avatars that bear minimal resemblance to their actual features, potentially resulting in a disconnection and exasperating discrepancy. There was also the concern that they might over-emphasise body areas of concern potentially leading to heightened dissatisfaction.

Given the well-evidenced prevalence of body image concerns in society (Rodgers et al., 2023), as a research team we prioritised ethical considerations throughout the study design and wanted to mitigate the risk of inadvertently heightening body discrepancy or dissatisfaction. This awareness informed the decision to make the avatar creation process a computerised one, where avatars were automatically created using participant photographs. Indeed, this reduced the participants' control over the avatar's appearance and potentially affected their sense of ownership over the avatar. A step taken to address this was to provide participants with ten different options that they could select for their avatar's body shape and were asked to select one that they felt best represented their own.

By streamlining the avatar personalisation process using computerised software, it helped with somewhat standardising the process and ensuring a baseline consistency which is crucial in research. It potentially reduced the risk of bias in users creating avatars or altering features in line with beauty standards or insecurities. It also enhanced productivity and efficiency, this approach not only saved researcher time, but upon reflection, was the most feasible way to make 50 avatars with limited time and ongoing research, clinical, and academic demands. While the computerised process still required approximately 30 minutes to create and build each avatar, this method offered crucial flexibility. Avatars could be created remotely, which accommodated busy clinical schedules, limited on-site room availability, and minimised participant burden as they only needed to attend in person for the intervention alone.

Indeed, there were also challenges to this approach. To maximise avatar quality and personalisation, there was a reliance on participants to send high-quality photographs meeting specific criteria. The ideal photograph was a passport-style photo, against a neutral background, unedited, and without glasses. Unfortunately, our experience was that several

participants submitted photographs that deviated from this. Many of the images were digitally enhanced, for example, to brighten the appearance of the individual and the background, or to smooth the appearance of the skin. It is possible that there was an element of social desirability or participants felt pressured and wanted to present their ideal self. This may reflect the pervasive influence of beauty standards and flawless photographs may be considered 'the norm' (MacCallum & Widdows, 2018; Farrid, 2009). Fortunately, the majority of these photographs with minor edits produced acceptable results, it is possible that the software lacks the sophistication to precisely translate the enhancements to the avatars. However, for a small minority, excessive background enhancements hindered avatar creation and participants were contacted to submit alternative photographs.

Avatar Satisfaction and Uncanny Valley

Informal comments made by participants with personalised avatars revealed a spectrum of experiences and expectations regarding the extent of personalisation. While some of the participants in the personalised group expressed satisfaction and feeling impressed by the level of detail of their avatars, others noted that they struggled to recognise themselves in their avatars.

A number of the participants referenced the uncanny valley phenomenon, coined by Mori (1970) and describes where an object approaches human-like realism but falls short, eliciting feelings of unease or a sense of eeriness for the user. This discomfort was not specific to the personalised group, suggesting that factors beyond personalisation contribute to this sensation. Informal feedback suggested that while avatar facial and body appearance likely played a role in this experience, other aspects of the avatars contributed too, for instance, participants reported that unnatural hand or mouth movements disrupted the experience for them.

This discrepancy in experience highlights the subjective nature of avatar design and the challenges of tailoring VR experiences to diverse user expectations, which was difficult to balance as researchers. We postulated about what factors might have influenced this spectrum of experience. Firstly, it seemed that participants had diverse preferences for aesthetics and levels of realism, some described preferring less real or more cartoon-like avatars while others expressed wanting a more realistic avatar. This was difficult to juggle in the research as we wanted to create a standardised experience, however consequentially this diversity in expectations may have resulted in some participants feeling less able to embody their avatar.

Additionally, observations during participant interactions suggest that prior VR experience played a role in users' evaluation of the avatars and the intervention. It seemed that users with prior VR experience tended to have higher expectations for avatar realism and the overall sophistication of the intervention. This aligns with existing research by Hameed and Perkis (2024), who found that users with more VR experience hold higher expectations for believability and realism. However, it seemed that those with no VR experience had positive impressions regarding the level of technological advancement of the avatars and intervention.

These observations may favour a more user-centred approach to avatar design in this intervention, allowing for a greater understanding of individual preferences, aesthetics, and expectations from previous experiences of VR. However, these reflections hopefully further contextualise the dilemmas faced as a researcher attempting to strike a balance with what will optimise participant experience while being feasible with our resources.

Recruitment and Generalisability

A limitation referenced in the empirical study was the representativeness of the sample, 54% identified as East Asian, which is not representative of the demographic makeup of the UK. The recruitment strategy adopted, which utilised the university's subject pool may account for this overrepresentation as the university has a culturally diverse population. In 2023, University College London reported that 55% of the student population is international. (https://www.ucl.ac.uk/about/what/key-statistics).

The study's sample lacked sufficient representation from various cultural backgrounds in the UK. This became apparent midway through recruitment and a dilemma faced by the research team was how to achieve a representative sample while maintaining a naturalistic recruitment process. A more diverse sample encompassing a wider range of cultural backgrounds would improve the generalisability of the research and help to broaden our understanding of personalisation and self-compassion in a wider cultural context. However, interfering with recruitment midway through may have inadvertently introduced bias.

When faced with this dilemma, my reflections were driven by existing research outlining cultural variations in how self-compassion is conceptualised and experienced, particularly between collectivist and individualistic cultures (Kitayama et al., 1997; Neff et al., 2008; Steindl et al., 2020). Additionally, I wondered about cultural variations in the experience of avatar personalisation. When reflecting, I held in mind the work of Tinmaz & Dhillon (2024) where a third of their participants reported that they were influenced by cultural and regional prompts. This suggests that cultural background may play a role in user preferences when using an avatar.

Ultimately, the recruitment process in this study presented challenges in achieving balanced demographic representation. In light of these reflections, moving forward, I would steer away from using a university participant pool and use a wider range of recruitment methods and platforms to maximise representation with the hopes of increasing the generalisability of findings.

Key Learning Points

The most rewarding part of this project was collaborating with participants and introducing them to compassion-focused theory. Notably, for many it was their first encounter with compassion theory, and for some, their first experience of a psychological intervention. Conversations with participants highlighted unfamiliarity with some of the practised concepts (validation, redirection of attention, and memory reactivation), with some reporting this as feeling 'awkward' or 'unnatural' for them. However, the IVR intervention provided them with an opportunity to practice these skills in a non-threatening environment. Some participants even shared examples of how they planned to apply these skills in real-life challenges. This experience reaffirmed for me the power of experiential learning and the potential of VR interventions to make therapeutic concepts more accessible and engaging.

Furthermore, as a trainee clinical psychologist, I often work with people in services who are unfamiliar with psychology or who are experiencing therapy for the first time. However, working with the non-clinical sample in this study re-emphasised the benefits of fundamental therapy skills, such as empathy and containment. Several participants spoke about feeling positively impacted by the study, and having learned new skills they could apply to their own challenges. Overall, this project highlighted for me the potential ripple effect of such

interventions: upskilling people by providing them with accessible tools for self-management and empowering them to navigate challenges in their lives with these tools.

Conclusions

This critical appraisal has served as a valuable opportunity to reflect on my entire research journey. It has allowed me to not only contextualise some of the limitations discussed in the empirical study but also to reconnect with the initial passions that fuelled this project. As when deep into research, those passions can become overshadowed by challenges faced along the way.

The reflection process reminded me that the majority of decisions and trade-offs, which are inevitable in any research project, were navigated alongside my co-researcher and supervisor. This shared decision-making helped incorporate more diverse perspectives, enhance problem-solving, share accountability and ownership, and most importantly allow for supportive learning opportunities.

I hope this appraisal offers insight and support for other new researchers navigating their own research journey.

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Appendices

Appendix A

The Researchers' Contributions To The Joint Project

This project was jointly run with Katherine Free. Siobhan Fitzpatrick's study was quantitative in nature and sought to understand if the personalisation of avatars in the IVR intervention resulted in a greater improvement in self-compassion, self-criticism, and VR experience. Siobhan's study also explored the influence of body satisfaction. Katherine's study was to qualitatively explore participants' experiences of having a personalised avatar designed and used in the IVR intervention.

Tasks such as completing the ethics amendment document, amending information sheets and consent forms, and registering the study on the SONA recruitment platform were completed jointly. Other tasks were completed separately but with liaison from each other, for example, Siobhan composed the questionnaire for participants on Microsoft Forms and Katherine developed the questions for the qualitative study, however, these were reviewed by each other before finalisation.

When running the study with participants, both researchers recruited and facilitated the IVR intervention with participants, this involved sending pre-intervention questionnaires, photograph guidelines, and developing avatars. Katherine supported with running the IVR intervention until she reached data saturation for her qualitative study, and Siobhan supported with conducting a small number of qualitative interviews. The organisation of incentives was managed jointly.

Finally, all data analyses and write-ups were completed separately.

Appendix B

Original Ethics Application and Approval

DIVISION OF PSYCHOLOGY AND LANGUAGE SCIENCES

Ethics Application Form for Non-Invasive Research on Healthy Adults

When preparing your ethics application, please take care to ensure that it reads well and is free from typographical and other errors. While this might seem a bit pedantic, it is worth bearing in mind that the ethics application form is an official document that may, in exceptional circumstances, need to be produced and scrutinized by others. A useful way of thinking about this might be to imagine what might happen if the document was being scrutinized by someone with a complaint about your study: is there anything in it that seems unprofessional or a bit sloppy, or that could be used, inadvertently or otherwise, to harm your reputation, or the reputation of the department or university?

SECTION A APPLICATION DETAILS

A1 Project details

Project title: Avatar embodiment within virtual reality

Date of submission:

Proposed start date: 19 July 2021

Proposed end date: 18 July 2026
(this can be up to 5 years from start date):

A2 Principal researcher

(Note: A student – undergraduate, postgraduate or research postgraduate – cannot be the principal researcher for ethics purposes).

Full name: John King

Position held: Professor

Research Department: CEHP

The principal researcher must read and sign (electronic signature or scanned pdf with signature are acceptable) the following declaration. Please tick the box next to each of the statements below to acknowledge you have read them and provided all required information.

▪ I will ensure that changes in approved research protocols are reported promptly and are not initiated without approval by the Departmental Ethics Committee, except when necessary to eliminate apparent immediate hazards to the participant.	x
▪ I have completed a risk assessment for this programme of research and hereby confirm that the risk assessment document will be discussed with any researcher/student involved in this programme of research (currently or in the future). I will ensure that all researchers/students sign the risk assessment form following this discussion. **Risk assessment forms for projects can be downloaded from the Ethics section of the PaLS Intranet.**	x
▪ I have completed the Information Governance training provided by ISG	x
▪ I have obtained approval from the UCL Data Protection Officer stating that this research project is compliant with the General Data Protection Regulation. My Data Protection Registration Number is: _____ You can find a data protection registration form at: http://www.ucl.ac.uk/legal-services/research	Registration in progress.

Note: your data protection number could cover a whole programme of research. It is not always necessary to request a data protection number for each individual project.	
▪ I have included examples of the Information Sheet and Consent Form for the proposed research. It will be made clear to the participants that they can withdraw from the study at any time, without giving a reason.	x
▪ I will ensure that all adverse or unforeseen problems arising from the research project are reported in a timely fashion to the UCL Research Ethics Committee.	x
▪ I will undertake to provide notification when the study is complete and if it fails to start or is abandoned.	x
▪ I have met with and advised students on the ethical aspects of this project/programme of research.	x
▪ I am satisfied that the proposed research complies with current professional, departmental and university guidelines.	x

Signature: **Date: 15 July 2021**

A3 Contact details

Principal Researcher

Full name: Prof John King

Position held: Professor

Research Department: Clinical Cognitive Neuroscience

Email: Telephone:

Additional applicant 1

Full name: Amy Barrington

Position held: Trainee Clinical Psychologist (on doctorate in clinical psychology course)

Research Department: Clinical, education and health psychology

Email: Telephone:

Additional applicant 2

Full name:

Position held: *(undergraduate/taught master's/MRes/research student/postdoctoral/staff)*:

Research Department:

Email: Telephone:

(Add further details on a separate sheet if there are more applicants to be covered by this form)

A4 Approval from the Departmental Ethics Committee

(Approval cannot be given by the principal researcher of this project – if necessary the application must be sent to an Ethics Officer from a different Research Department, or to the College Ethics Committee, for approval)

Declaration by the Research Department Ethics Chair:

I have reviewed this project and I approve it. X

The project is registered with the UCL Data Protection Officer and a formal signed risk assessment form has been completed.

Allocated Departmental Project ID Number for the approved application:

__CEHP/2021/587_____

Name of the Research Department Ethics Chair (type in):	Jean-Baptiste Pingault
Date:	15/07/2021

SECTION B **PROJECT DETAILS**

B1 **Summary of Research**

It is particularly important to provide sufficient detail of the research protocol and the measures that will be used, to enable evaluation of the application on ethical grounds. It is also important to clearly demonstrate that the proposed measures are 'innocuous' and fall within PaLS Ethics remit.

Please provide a brief summary of the project/programme of research including

- Background
- Aims
- Participants and recruitment
- Procedure (including whether face-to-face or online study)
- Measures
- Examples of measures (tests, questionnaires, interviews etc.) as per RD guidelines

NB When providing examples of each measure you plan to use, please select the most emotive/distressing examples so that the Ethics Chair can judge the potential for causing any distress.

In previous research we used a feature of virtual reality known as 'embodiment' to improve self-compassion. Embodiment replaces a person's real body with a life-sized virtual body that exactly copies the movements of the real body. This generates an illusion of ownership over the virtual body. We had individuals first embody an adult and speak compassionate words to a virtual distressed child. The child responded by becoming less distressed. They then embodied the child and experienced the interaction from the child's perspective. This technique helped patients to feel what it is like to be compassionate to themselves. We have been funded to continue this research and wish to undertake a series of adjunct studies with healthy adults – this application for programme ethics will cover that adjunct work. I describe below the first study, which will be undertaken for a DClinPsy project. The programme approval is sought to enable a series of linked studies over several years for successive cohorts of DClinPsy students, who would benefit greatly from obtaining approval via brief amendments.

The next studies, to be initiated in 2022 will examine the impact of avatar personalisation. We predict that where a participant's avatar is a direct copy of their own face and body, identification will be higher and thus the impact of our self-compassion training will be greater. We will investigate this with a student sample initially, screen for high levels of self-criticism. Two DClinPsy projects will be conducted on avatar personalisation, one qualitative seeking to understand the most important themes to investigate in a later clinical sample; and a quantitative project looking at the magnitude of change on measures of self-compassion and self-criticism.

Further studies on avatar characteristics will look at body-image and self-esteem. While self-identical avatars may improve identification, we do not know what the impact will be where individuals have lower levels of self-esteem or self-critical styles that focus on body image. We will again recruit student samples, this time screening for those meeting these self-referential criteria, and again use a split qualitative/quantitative approach.

Data management will be compliant with UCL Research Information Governance guidelines and GDPR. Any identifying information needed (to facilitate communication prior to testing, and remuneration) will be deidentified in the research database by the use of numerical codes, and the person:code lookup table will be stored password encrypted. Data will not be transferred outside the UK. Personal data will be deleted within five years of study completions at the latest. The right to withdraw from any study will be maintained and any withdrawing participant will have their personal data withdrawn where this is feasible. If this is not feasible due to anonymity this will be made clear prior to consent.

Participants for all these studies will be recruited from the UCL Psychology Department subject pool where an invitation/advertisement to take part in the study will be posted. Self-report of a psychiatric condition and/or current treatment for a mental health problem will be an exclusion criterion, as will physical mobility disabilities, epilepsy, or other neurological conditions that would raise safety risks. A history of motion-sickness would also be an exclusion criterion.

Study One is an adapted replication of Falconer et al.'s (2014, 2016) studies which found that an Immersive Virtual Reality (IVR) intervention was effective in inducing self-compassion and reducing self-criticism in both healthy and clinical adult samples. This study aims to determine if an IVR paradigm in which an individual embodies the virtual avatar of *a person they perceive as compassionate* can facilitate (and enhance) the experience of receiving self-compassion. The study will investigate if the embodiment of a perceived compassionate avatar as opposed to a generic avatar has a more significant effect on reducing self-criticism, increasing positive affect and reducing fears, blocks and resistances (FBRs) to compassion.

This study will recruit a healthy, student population who are high in self-criticism but not currently struggling with a psychiatric condition to allow us to investigate and further understand the effects of the IVR intervention before its potential use in a clinical population. The study could provide promising support for an alternative IVR intervention which helps cultivate 'the compassionate self'. This could be of particular importance for individuals whose FBRs to compassion (and associated attachment styles) mean they struggle to practice and utilise other compassion-focused therapeutic techniques (such as imagery/'acting').

Study Aims

-The first aim of the study is to investigate if an adapted version of the IVR paradigm used by Falconer (2014; 2016), in which participants embody a perceived 'compassionate other' is effective in inducing self-compassion, reducing self-criticism and reducing FBRs to compassion.
-The second aim of the study is to investigate if embodying a perceived 'compassionate other' is more effective at inducing self-compassion, reducing self-criticism and reducing FBRs to compassion than embodying a generic virtual avatar.
-The third aim of the study is to investigate whether or not an individual's attachment style has any impact on their experience of the IVR paradigm and therefore moderates the effects on self-compassion/self-criticism, positive/negative affect and FBRs to compassion.

Design

The study will use a mixed-model experimental design, where Time (pre and post IVR intervention) is the within-participants independent variable and Embodied Avatar (generic or compassionate other) is the between-participants independent variable. In the generic avatar condition, each participant will embody the same 'generic' avatars as those used in Falconer et al.'s (2014; 2016) studies. In the Compassionate Other avatar condition, participants will embody the avatar of a public figure they have chosen and perceive as being a compassionate person.

The dependent variables will be measures of self-criticism and self-compassion, fears, blocks and resistances to compassion and mood (both positive and negative).

Study One procedure, participants and recruitment:

The study protocol will mirror the protocol of Falconer et al. (2014) study. Participants will be asked to complete an online screening questionnaire (the FSCSR – see Measures below) using Qualtrics. If participants meet the high self-criticism criterion (scoring in the upper third of a large sample of undergraduates, i.e. above 20, on the Inadequate Self subscale of the FSCSR) they will be asked to supply their email address. No personal data or identifiers will be collected from participants who do not meet threshold for self-criticism and therefore will not be recruited to the study.

50 participants who meet criteria for self-criticism will be invited to take part in the study (via email) and will be sent a full description of the study (participant information sheet) and the opportunity to ask any questions before providing written informed consent. Participants email addresses will be stored in a secure encrypted file only accessible to the researcher. Participants email addresses will be randomly coded to a pseudonymized ID number. Participants will be asked to complete a number of questionnaires during the study (via Qualtrics) concerning their relationship to compassion, self-compassion and self-criticism, positive and negative affect and feelings in relationships with others. Special category data (ethnicity, age and gender) will also be collected. All data collected will be stored separately to participants email addresses using their pseudonymised ID number.

-Participants will be randomly allocated into one of two groups (generic avatar condition and perceived compassionate other avatar condition). Participants allocated to the compassionate other avatar condition will be given instructions and asked to provide a photograph of a public figure they perceive

as being compassionate. Participants will be offered psycho-education materials which define compassion and the qualities of compassion and guidance in choosing their 'compassionate' person. Participants who fail to provide an appropriate photograph will be excluded from the study.

Participants will be invited to take part in the IVR intervention following completion of the following online questionnaires (SSCCS, CAES, FOCS, FSCRS, AAS, TPAS and the iPANAS – see Measures below), the order of which will be randomized across participants.

-On arrival, participants will again be given the opportunity to ask any questions about the VR intervention and opportunity to withdraw if they choose. Participants will then be given information concerning compassion and task instructions that present a staged approach to reducing distress based on current knowledge and practice in compassion focused therapy. Participants will be introduced to three essential stages for giving a compassionate response: **1. Validation:** *The aim of this stage is to acknowledge that the other person is upset, that you do not judge them for this, and that it is perfectly acceptable for them to react in this way.* **2. Redirection of Attention:** *The aim of this stage is to direct the other person's attention towards something that is more positive, soothing, and comforting.* **3. Memory Activation:** *The aim of this stage is to suggest that the person could try to recall a memory of a person who loves or is kind to them. This memory is supposed to instil more positive feelings of warmth, comfort, and safety.*

Participants will be given generic sentences that correspond to each of these three stages. They will be instructed to memorise these sentences as best they could so as to deliver them slowly, softly, and compassionately to the child. Participants can practice their lines with the researcher to ensure that they are comfortable expressing themselves.

Participants will then take part in either the generic avatar IVR intervention or the perceive compassionate person avatar embodiment IVR intervention depending on the condition they have been allocated to. Participants in the compassionate person condition will be embodied in an avatar that resembles the person they perceive as being compassionate by using the photograph provided and VR technology to generate an avatar.

During the IVR intervention, participants voices and movements will be captured and recorded to enable their playback in the last part of the session. These will be deleted immediately after the session ends.

Following the IVR intervention, participants will be asked to complete the same state and trait measures again online using Qualtrics. Data will be analysed using Jasp statistics software.

Measures:

Forms of Self-Criticizing/Attacking & Self-Reassuring Scale (FSCRS). We will use the FSCRS [25] to measure *trait* self-criticism and self-reassurance. Participants indicate on a 5- point Likert scale the extent to which various statements are true of themselves (0 = not at all like me to 4 = extremely like me). The scale comprises three subscales: inadequate self (IS, range 0–36; e.g. ''There is a part of me that feels I am not good enough''), hated self (HS, range 0–20; e.g. ''I stop caring about myself''), and reassured self (RS, range 0–32; e.g. ''I find it easy to forgive myself''). The scale has high internal reliability, with Cronbach's alphas of.90 for IS, and.86 for HS and RS scales. The scale has been validated in both healthy and clinical populations [26].

Self-Compassion and Self-Criticism Scale (SCCS). We will use the SCCS (see Falconer et al., 2013, Manuscript S1) to measure *state* self-compassion and self-criticism. The scale consists of five scenarios that are potentially self-threatening and can elicit varying degrees of self-criticism or self-compassion (e.g., ''A third job rejection letter in a row arrives in the post''; ''You arrive after walking to a meeting to find that you are late and the doors are closed''). Participants are instructed to imagine, as vividly as possible, that these scenarios are happening to them at the current moment in time and rate on 7-point Likert scales (1 = not at all to 7 = highly) the extent to which they would react to themselves in a Harsh, Contemptuous, Critical, Soothing, Reassuring, and Compassionate manner in relation to each imagined scenario. The scale is separated into two orthogonal subscales. The positive items are summed across scenarios to generate the Self-Compassion Scale (range 15–105) and the negative items are summed to generate the Self-Criticism Scale (range 15–105). The scale has good

internal reliability with Cronbach's alphas of.91 and.87, respectively. Overcoming Self-Criticism in Virtual Reality PLOS ONE | www.plosone.org 2 November 2014 | Volume 9 | Issue 11 | e111933

International Positive and Negative Affect Schedule, Short Form (I-PANAS-SF). We will use the 10-item I-PANAS-SF [27], a cross-culturally reliable and briefer version of the original PANAS [28] to measure positive and negative affect. Participants rate how strongly they are currently experiencing a particular emotion on a 5-point Likert scale (1 = not at all to 5 = very much so) (e.g. PA, range 5–25: active, inspired; NA, range 5– 25: ashamed, hostile). Cronbach's alphas for the PA and NA scales are.78 and.76 respectively [27].

Two Forms of Positive Affect Scale (TFPAS). We will use the TFPAS to measure positive affect. The scale measures the extent to which participants experience 18 different positive emotions. Factor analysis has revealed three potential forms of positive affect: Active Affect (e.g. energetic, excited), Relaxed Affect (e.g. relaxed, calm) and Safe Affect (e.g. content, warm). The significance of this scale is that it allows for a better approximation of affect systems associated more specifically with self-compassion [4,29]. Participants rate on a 5-point Likert scale (1 = not at all to 5 = very much so) how strongly they are experiencing these emotions at the current moment in time. There are 4 Safe Affect items (range 4–20), 6 Relaxed Affect items (range 6–30), and 8 Active Affect items (range 8–40). The authors reported a Cronbach's alpha of.83 for Active and Relaxed Affect, and.73 for Safe Affect.

Fears of Compassion Scales. We will use the Fear of Compassion Scales to measure participants fears and blocks to compassion (to self, from others, to others). Three related scales assess traits consisting of fear of experiencing compassion for oneself (15 items: example, 'I fear that if I am more self-compassionate I will become a weak person'), fear of receiving compassion from others (13 items: example, 'When people are kind and compassionate towards me I feel anxious or embarrassed') and fear of experiencing compassion for others (10 items: example, 'People will take advantage of me if they see me as too compassionate').19 All items are rated on a 5-point scale from 0 ('don't agree at all') to 4 ('completely agree'). High internal reliability (coefficient alpha 0.78–0.85) and validity data have been reported.

B2	**Will the results be disseminated outside the standard academic outlets?**	☐	**Yes**	☒	**No**

	If you answered 'yes', please specify:

B3	**Please outline any ethical issues that might arise from the proposed study and explain how they will be addressed.**

Written informed consent will be obtained from all participants.

The measures used in this study are regarded as innocuous for healthy participants however the researchers are mindful that they will be recruiting participants with high levels of self-criticism. For some participants it is possible that activation of their soothing/affiliative system during the VR intervention may also simultaneously activate their threat system (depending on life/attachment experiences). We will inform participants that if they wish to stop the experiment for any reason they can do so without explanation.

Participants will be given the opportunity to discuss any concerns or issues that the study might have raised for them at any time before during or after taking part and will be signposted to appropriate mental health support (i.e. their GP and/or student support services) should they want to access it as well as further reading around the study content (for example compassion focused therapy and attachment theory). Participants will have contact details of the researcher and/or the PI, John King (Clinical Psychologist) should they wish to discuss anything further. This information will all be shared in the Participant Information sheet. Participants will be debriefed and all the above information will be additionally shared in the participant information sheet.

Any disclosure of risk during the study will be responded to in a sensitive and transparent way. The research team, which will always involve a clinical psychologist, will carry out a risk assessment before deciding on which next steps are most appropriate – in most cases informing anyone else may not be necessary if it feels that the risk can be managed by discussing a safety plan with participants and signposting to relevant services. Should it feel necessary then emergency services will be contacted and participants will be informed as to why such steps will be taken to ensure their safety and/or the safety of other people.

Virtual Reality:

To minimize risks we will exclude participants who have any neurological condition, any physical disorder or disability that affects mobility, people with epilepsy, and people under treatment for any mental health disorder.

The physical environment for VR testing needs to be clear of trip hazards such as furniture and cables. The system software includes a boundary which will warn participants if they have moved outside of a safe zone, and at no point will they be unobserved.

People can sometimes experience a degree of nausea when using virtual reality. We inform participants of this prior to the experiment. Participants are also informed that if they do experience nausea during the experiment they can stop at any time they wish. Modern headsets tend not to induce nausea thanks to minimal visual latency and high refresh rate panels.

There has been some research showing that the use of head mounted displays can disturb vision – up to approx. 30 minutes after use. This risk is small and no long term effects study is known to us. Participants are informed of this prior to participation in the experiment. We also ask participants to take precautions after the experiment if they do feel like their vision has become disturbed and will make it clear that vehicles and machinery should not be operated in the 30 minutes after the VR experience

There have been reports that virtual reality can induce flashbacks and epileptic seizures in susceptible individuals. There are no reliable data on this but as part of a network of VR researchers,

SECTION C **PARTICIPANT DETAILS**

C1 **Participants to be studied**

Number of volunteers:	300
Upper age limit:	None
Lower age limit:	18

C2 **Payment**

Will payment or any other incentive (e.g. a gift voucher or free services) be made to any research participant? **University students will receive course credit**

Yes ☐ **No** ☐

C3 **Recruitment**

(i) Describe how potential participants will be identified:
(ii) Describe how potential participants will be approached and recruited:

Participants will be recruited from the UCL Psychology Department subject pool where an invitation/advertisement to take part in the study will be posted. Later studies may recruit from advertising to the general population.

For Study One, participants will be asked to complete an online screening questionnaire (the FSCSR) using Qualtrics. If participants meet the high self-criticism criterion (scoring in the upper third of a large sample of undergraduates, i.e. above 20, on the Inadequate Self subscale of the FSCSR) they will be asked to supply their email address. No personal data or identifiers will be collected from participants who do not meet threshold for self-criticism and therefore will not be recruited to the study.

Participants who meet criteria for self-criticism will be invited to take part in the study (via email) and will be sent a full description of the study (participant information sheet) and the opportunity to ask any questions before providing written informed consent. Participants email addresses will be stored in a secure encrypted file only accessible to the researcher. Participants email addresses will be randomly coded to a pseudonymized ID number.

C4 **Will the participants participate on a fully voluntary basis?** **Yes** ☒ **No** ☐

Will UCL students be involved as participants in the research project? **Yes** ☒ **No** ☐

C5 **Deception**

Will any form of deception be used that raises ethical issues? If so, please explain.

No

C6 **Will you provide a full debriefing to the participants?** **Yes**

If 'No', please explain why below.

C7 **Information Sheets And Consent Forms**

You must attach the final information sheet and consent form for your participants with this application. This will already have received approval from the Data Protection Team. Templates are available on the PaLS intranet (please note that these changed at the end of 2017, so as to be compliant with new Data Protection regulations

Appendix C

Participant Information Sheet

Division of Psychology & Language Sciences
Faculty of Brain Sciences

Participant Information Sheet For Adults

This study has been approved by PALS Research Department's Ethics Chair [Project ID: CEHP/2021/587]

Title of Study: The experience of creating and using a personalized avatar when completing a self-compassion virtual reality intervention

Name and Contact Details of the Researcher(s):
Katherine Free (Trainee Clinical Psychologist) and Siobhan Fitzpatrick (Trainee Clinical Psychologist)
University College London

Name and Contact Details of the Principal Researcher:
Prof. John King , Research Department of Clinical, Education and Health Psychology
University College London

1. **Invitation to take part in a research study**
   We would like to invite you to take part in our research study. You should participate only if you want to do so. Before you decide whether to take part, we would like you to understand why the study is carried out, what you would be asked to do, and how the study will be conducted. Please take some time to read this sheet thoroughly, and to discuss it with other people if you wish. One of our team will go through the information sheet with you and answer any questions you have. Please feel free to ask any further questions about the study, or if you find anything on this sheet unclear.

2. **What is the project's purpose?**
   We are interested in participant's experience of creating and using a personalised (self-representative) avatar during a virtual reality self-compassion intervention. We are particularly interested in the potential positive and negative aspects of this experience. We are also interested in understanding the role of body image when using generic (not personalised) vs personalised avatars.

3. **Why have I been chosen?**
   You are a healthy adult and you have volunteered to take part in this study. There will around 50 participants in this study.

4. **Do I have to take part?**
   No. Your participation in the study is entirely voluntary. It is your choice whether or not you would like to participate. If you do give consent to take part in the study, you are still free to leave the study at any point, without giving a reason. If you leave, any information for the research that we have already collected from you will be destroyed.

5. **What is the research study's inclusion criteria?**
   In order to take part in this research study you must:
   - Be 18+ years old
   - Be fluent in the English language
   - Not be experiencing current mobility difficulties
   - Not currently be in treatment for any mental health difficulty

6. **What will happen to me if I take part?**
   If you agree to participate, you will be asked to attend a session at Torrington Place. We will go through this Information Sheet and answer any questions you might have about the study. If you decide to take part, you will be asked to sign a consent form. You will need to have sent a passport style photograph of yourself to the researcher(s) prior to attending the session. You will be asked to complete some questionnaires and take part in a virtual reality self-compassion experience.

   Below is a summary of what the study will entail from start to finish:

   - You will randomly be allocated to one of two conditions: you will experience self-compassion when you are embodied in virtual reality as a generic avatar (human body) or alternatively, you will experience self-compassion when you are embodied in virtual reality as a personalised avatar (self-representative body).
   - If you are allocated to the personalised avatar condition you will create a self-representative avatar with the researcher using VR technology. This will use a passport style photo of you and you will be able to adjust features such as clothing and hair style.
   - You will be asked to complete a number of questionnaires which look at body image satisfaction, relationship to compassion, different emotions you experience and your feelings about relationships with others.
   - The researcher will then give you information about compassion based on current psychological knowledge and practice in compassion focused therapy. The researcher will give you task instructions and guide you through reading a 'compassionate script'. You will have opportunities to ask questions and practice lines to ensure you feel comfortable expressing yourself.
   - You will then take part in the virtual reality experience where you will embody either a generic avatar or a personalised avatar and will experience both giving and receiving compassion.
   - The researcher(s) will ask you to complete a number of the same questionnaires again.
   - If you are allocated to the personalised avatar condition you may also be invited to an interview with one of the researchers. This will explore your experience of creating and using the personalised avatar during the self-compassion virtual reality intervention. The interview will last for approximately 60 minutes and will be audio recorded using a Dictaphone.

At the end of the session, the study researcher(s) will conduct a debriefing and address any other questions or concerns you may have. The duration may vary from person to person, but we don't expect it to take more than two hours.

7. **What are the possible disadvantages and risks of taking part?**
   Immersive VR can induce disorientation and, in very rare cases, nausea. These problems are unlikely to occur during this study as we are using a set-up in which the virtual and physical movements are always synchronised. We will support you if you become upset or distressed during the study. You will be given time at the end of the study to be fully debriefed with a member of the research team.

8. **What are the possible benefits of taking part?**
   Previous studies using a similar immersive virtual reality intervention have found positive effects for participants who have been involved – participants have reported a significant increase in positive emotions and a reduction in negative emotions following the experience. It has also been found that the experience has led to a decrease in self-criticise and an increase in self-compassion. We hope that one possible effect of this experience could be a change in people's attitude towards compassion. The experience also provides psychological education around concepts of compassion and a stepped approach to providing a compassionate response to someone in distress.

9. **What if something goes wrong?**
   If you have further questions or concerns regarding participation in this research study you may contact one of the researchers detailed on this form. If you are unhappy with how you have been treated or if you have been injured whilst participating in this study please contact the Principal Investigator (John King). If you feel your complaint has not been handled in a satisfactory way (by a researcher or Principal Investigator), you should contact the Chair of the UCL Ethics Committee (ethics@ucl.ac.uk).

10. **Will my taking part in this project be kept confidential?**

All the information that we collect about you during the course of the research will be kept strictly confidential. The data collected from you will be pseudonymised and stored on a UCL password protected computers. You will not be able to be identified in any ensuing reports or publications.

11. Limits to confidentiality

Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this was the case we would inform you of any decisions that might limit your confidentiality.

12. What will happen to the results of the research project?

The data will be used only for the purpose of informing the research questions in this study and will only be accessed by the research team. The results may be published in scientific journals, but you will in no way be identifiable. We would be happy to send you a copy of any publications arising from the research or a summary of the main findings. The data will be retained for at least 5 years and may be accessed in the future by the research team for comparison with future data. Dr. John King is custodian of the data.

13. Data Protection Privacy Notice

The data controller for this project will be University College London (UCL). The UCL Data Protection Office provides oversight of UCL activities involving the processing of personal data, and can be contacted at data-protection@ucl.ac.uk.
UCL's Data Protection Officer is Lee Shailer and he can also be contacted at data-protection@ucl.ac.uk.

Your personal data will be processed for the purposes outlined in this notice. The legal basis that would be used to process your personal data will be the provision of your consent. You can provide your consent for the use of your personal data in this project by completing the consent form that has been provided to you.

Your personal data will be processed so long as it is required for the research project. If we are able to anonymise or pseudonymise the personal data you provide we will undertake this, and will endeavour to minimise the processing of personal data wherever possible.

If you are concerned about how your personal data is being processed, please contact UCL in the first instance at data-protection@ucl.ac.uk. If you remain unsatisfied, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/

13. Contact for further information

For questions and further information, please contact the researcher(s) (details above) or the principal investigator (details above).

You will be provided with a copy of this information sheet to take away with you.

Thank you for reading this information sheet and for considering to take part in this research study.

Appendix D

Participant Consent Form

Division of Psychology & Language Sciences
Faculty of Brain Sciences

CONSENT FORM FOR ADULTS

Please read the statements below after reading the information sheet.

Title of Study: The experience of using a personalized avatar when completing a self-compassion virtual reality intervention

Institute of Cognitive Neuroscience

Researcher(s): Katherine Free (Trainee Clinical Psychologist)

Siobhan Fitzpatrick (Trainee Clinical Psychologist)

Principal Researcher: Dr John King, *UCL Senior Lecturer*

The UCL Data Protection officer provides oversight of UCL activities involving the processing of personal data, and can be contacted at: data-protection@ucl.ac.uk

This study has been approved by the PALS Research Ethics Committee (Project ID Number: CEHP/2021/587).

Thank you for considering taking part in this research. If you have any questions arising from the Information Sheet, or explanation already given to you please ask the researcher(s) before you decide whether to take part in the study. You will be given a copy of this Consent Form to keep and refer to at any time.

I confirm that I understand that by ticking/initialling each box below I am consenting to this element of the study.

I understand that it will be assumed that any unticked/initia[illegible]nsent to that part of the study. I understand that by not giving cor[illegible]ay be deemed ineligible for the study.

		Tick Box
1.	I confirm that I have read and understood the Information Sheet for the above study. I have had an opportunity to consider the information and what will be expected of me. I have also had the opportunity to ask any questions which have been answered to my satisfaction.	
2.	I understand that all personal information will remain confidential and that all efforts will be made to ensure I cannot be identified. I understand that the passport style photograph (if supplied) will be deleted following completion of the intervention. I understand that all data gathered in this study will be stored anonymously and securely. I may be asked to take part in an interview which will be audio recorded using a Dictaphone. All interview data will be transcribed and anonymized, and any recordings will be deleted. I am aware that direct interview quotes may be used in publications but that I will remain anonymous throughout, and it will not be possible to identify me.	
3.	I understand that my information may be subject to review by responsible individuals from the University for monitoring and audit purposes.	
4.	I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	

	I understand that if I decide to withdraw, any personal data I have provided up to that point will be deleted unless I agree otherwise.	
5.	I understand the potential risks of participating and the support that will be available to me should I become distressed during the course of the research.	
6.	No promise or guarantee of benefits have been made to encourage me to participate	
7.	I understand that the data will not be made available to any commercial organizations but is solely the responsibility of the researcher(s) undertaking this study.	
8.	I understand that I will be compensated for the portion of time spent in the study with university course credits. I understand that if I participate in the additional interview, I will be compensated with a £10 voucher.	
9.	I agree that my anonymised research data may be used by others for future research. [No one will be able to identify you when this data is shared.]	
10.	I hereby confirm that: (a) I understand the exclusion criteria as detailed in the Information Sheet and explained to me by the researcher(s); and (b) I do not fall under the exclusion criteria.	
11.	I am aware of who I should contact if I wish to lodge a complaint.	
12.	I voluntarily agree to take part in this study.	
13.	I understand that use of the information for this project will be held up to the end of the experiment and up to a maximum 5 years from the end of it. I would be happy for the data I provide to be archived at the Institute of Cognitive Neuroscience under machines secured with passwords. I understand that other authenticated researchers will have access to my anonymised data.	
14.	**Overseas Transfer of Data** I understand data will not be transferred outside the EEA.	

If you would like your contact details to be retained so that you can be contacted in the future by UCL researchers who would like to invite you to participate in follow up studies to this project, or in future studies of a similar nature, please tick the appropriate box below.

	Yes, I would be happy to be contacted in this way	
	No, I would not like to be contacted	

_____	_____	_____	_____
Name of participant (If applicable)	Date	Signature	

_____	_____	_____
Researcher(s)	Date	Signature

Appendix E

Measures – Multidimensional Body-Self Relations Questionnaire – Appearance Scales (MBSRQ-AS)

MBSRQ

The following pages contain a series of statements about how people might think, feel, or behave. You are asked to indicate the extent to which each statement pertains to you personally.

Your answers to the items in the questionnaire are anonymous. In order to complete the questionnaire, read each statement carefully and decide how much it pertains to you personally

5. Before going out in public, I always notice how I look. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

6. I am careful to buy clothes that will make me look my best. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

7. My body is sexually appealing. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

8. I constantly worry about being or becoming fat. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

9. I like my looks just the way they are. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

10. I check my appearance in a mirror whenever I can. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

11. Before going out, I usually spend a lot of time getting ready. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

12. I am very conscious of even small changes in my weight. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

13. Most people would consider me good-looking. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

14. It is important that I always look good. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

15. I use very few grooming products. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

16. I like the way I look without my clothes on. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

17. I am self-conscious if my grooming isn't right. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

18. I usually wear whatever is handy without caring how it looks. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

19. I like the way my clothes fit me. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

20. I don't care what people think about my appearance. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

21. I take special care with my hair grooming. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

22. I dislike my physique. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

23. I am physically unattractive. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

24. I never think about my appearance. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

25. I am always trying to improve my physical appearance. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

26. I am on a weight-loss diet. *

- ◯ Definitely Disagree
- ◯ Mostly Disagree
- ◯ Neither Agree Nor Disagree
- ◯ Mostly Agree
- ◯ Definitely Agree

27. I have tried to lose weight by fasting or going on crash diets. *

- ◯ Never
- ◯ Rarely
- ◯ Sometimes
- ◯ Often
- ◯ Very Often

28. I think I am: *

- ◯ Very Underweight
- ◯ Somewhat Underweight
- ◯ Normal Weight
- ◯ Somewhat Overweight
- ◯ Very Overweight

29. From looking at me, most other people would think I am: *

- ◯ Very Underweight
- ◯ Somewhat Underweight
- ◯ Normal Weight
- ◯ Somewhat Overweight
- ◯ Very Overweight

30. How dissatisfied or satisfied you are with each of the following areas or aspects of your body: *

Face (facial features, complexion)

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied or Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

31. Hair (color, thickness, texture) *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

32. Lower torso (buttocks, hips, thighs, legs) *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

33. Mid torso (waist, stomach) *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

34. Upper torso (chest or breasts, shoulders, arms) *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

35. Muscle tone *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

36. Weight *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

37. Height *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

38. Overall Appearance *

- ◯ Very Dissatisfied
- ◯ Mostly Dissatisfied
- ◯ Neither Satisfied Nor Dissatisfied
- ◯ Mostly Satisfied
- ◯ Very Satisfied

Measures – The Self-Compassion and Self-Criticism Scale (SCCS)

SCCS

Below are several statements describing various situations. Accompanying each statement is a list of possible reactions that you may have in response to **yourself** during these situations. We would like you to rate on the scales the extent to which you would react to **yourself** in a specific manner in response to each situation, *as if the situation were happening to you at this moment in time.* Try to imagine each situation occurring as vividly as possible.

39. You arrive home to find that you have left your keys at work *

	1. Not At All	2	3	4	5	6	7. Highly
Reassuring	◯	◯	◯	◯	◯	◯	◯
Soothing	◯	◯	◯	◯	◯	◯	◯
Contemptuous	◯	◯	◯	◯	◯	◯	◯
Compassionate	◯	◯	◯	◯	◯	◯	◯
Critical	◯	◯	◯	◯	◯	◯	◯
Harsh	◯	◯	◯	◯	◯	◯	◯

40. You receive a letter in the post that is an unpaid bill reminder *

	1. Not At All	2	3	4	5	6	7. Highly
Reassuring	◯	◯	◯	◯	◯	◯	◯
Soothing	◯	◯	◯	◯	◯	◯	◯
Contemptuous	◯	◯	◯	◯	◯	◯	◯
Compassionate	◯	◯	◯	◯	◯	◯	◯
Critical	◯	◯	◯	◯	◯	◯	◯
Harsh	◯	◯	◯	◯	◯	◯	◯

41. You have just dropped and scratched your new Smartphone *

	1. Not At All	2	3	4	5	6	7. Highly
Reassuring	◯	◯	◯	◯	◯	◯	◯
Soothing	◯	◯	◯	◯	◯	◯	◯
Contemptuous	◯	◯	◯	◯	◯	◯	◯
Compassionate	◯	◯	◯	◯	◯	◯	◯
Critical	◯	◯	◯	◯	◯	◯	◯
Harsh	◯	◯	◯	◯	◯	◯	◯

42. You have just opened the washing machine door to find that your white wash has turned pink *

	1. Not At All	2	3	4	5	6	7. Highly
Reassuring	◯	◯	◯	◯	◯	◯	◯
Soothing	◯	◯	◯	◯	◯	◯	◯
Contemptuous	◯	◯	◯	◯	◯	◯	◯
Compassionate	◯	◯	◯	◯	◯	◯	◯
Critical	◯	◯	◯	◯	◯	◯	◯
Harsh	◯	◯	◯	◯	◯	◯	◯

43. After searching your bag you realise that you have lost a £20 note *

	1. Not At All	2	3	4	5	6	7. Highly
Reassuring	◯	◯	◯	◯	◯	◯	◯
Soothing	◯	◯	◯	◯	◯	◯	◯
Contemptuous	◯	◯	◯	◯	◯	◯	◯
Compassionate	◯	◯	◯	◯	◯	◯	◯
Critical	◯	◯	◯	◯	◯	◯	◯
Harsh	◯	◯	◯	◯	◯	◯	◯

Measures – Virtual Reality Experience Questionnaire

VR Experience

44. Presence - I felt like I was in a room where a child was crying as opposed to in a lab taking part in an experiment. *

1	2	3	4	5	6	7

I felt like I was in the lab — I felt like I was in a room where there was a child crying

45. Adult body ownership and agency - I felt as if the body I saw when I looked down was my own body. *

1	2	3	4	5	6	7

Not At All — Very Much So

46. Adult body ownership and agency - I felt as if the body I saw when I looked in the mirror was my own body. *

1	2	3	4	5	6	7

Not At All — Very Much So

47. Child body ownership and agency - I felt as if the body I saw when I looked down was my own body. *

1	2	3	4	5	6	7

Not At All — Very Much So

48. Child body ownership and agency - I felt as if the body I saw when I looked in the mirror was my own body. *

1	2	3	4	5	6	7

Not At All — Very Much So

49. Child recognises adult as self - I felt like I was in the child's role. *

1	2	3	4	5	6	7

Not At All — Very Much So

50. Child recognises adult as self - I could recognise myself as the adult when I was the child. *

1	2	3	4	5	6	7

Not At All — Very Much So

51. Child recognises adult as self - I could recognise myself in the movement of the adult when I was the child. *

1	2	3	4	5	6	7

Not At All Very Much So

52. Child sense of being comforted - I felt like I was giving myself compassion when I was the child. *

1	2	3	4	5	6	7

Not At All Very Much So

53. Child sense of being comforted - I felt comforted by myself as the adult when I was the child. *

1	2	3	4	5	6	7

Not At All Very Much So

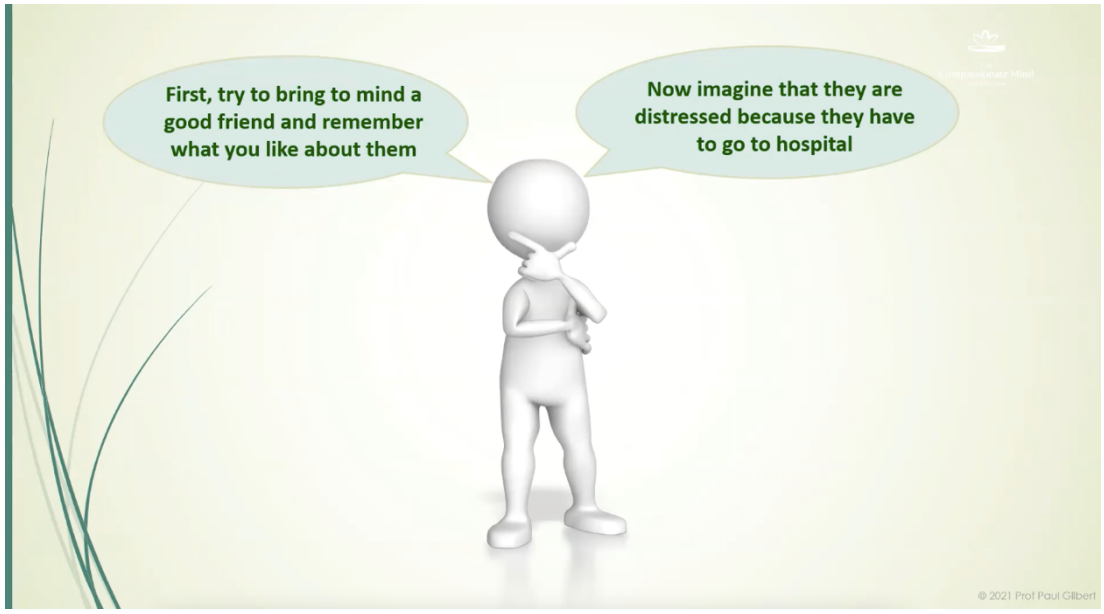
54. Child sense of being comforted - I felt reassured by myself as the adult when I was the child. *

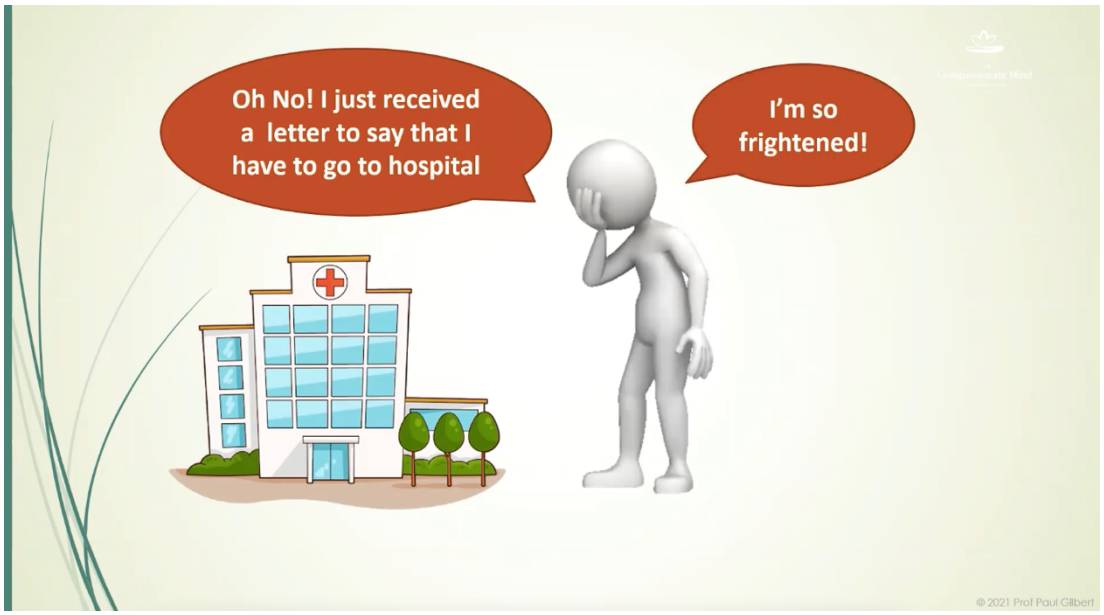
1	2	3	4	5	6	7

Not At All Very Much So

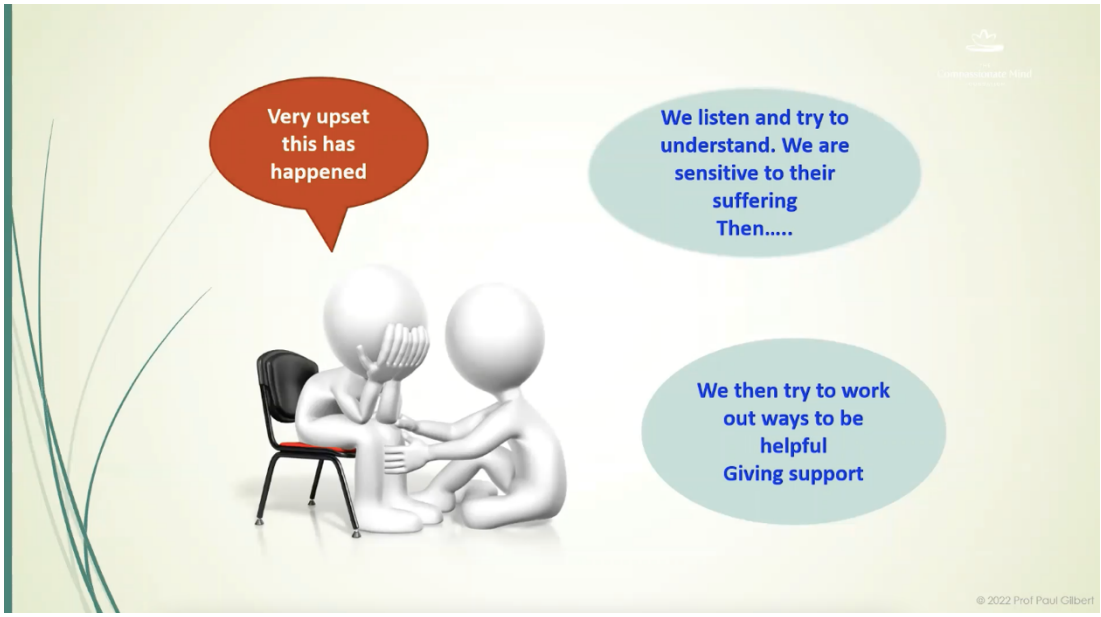
Appendix F

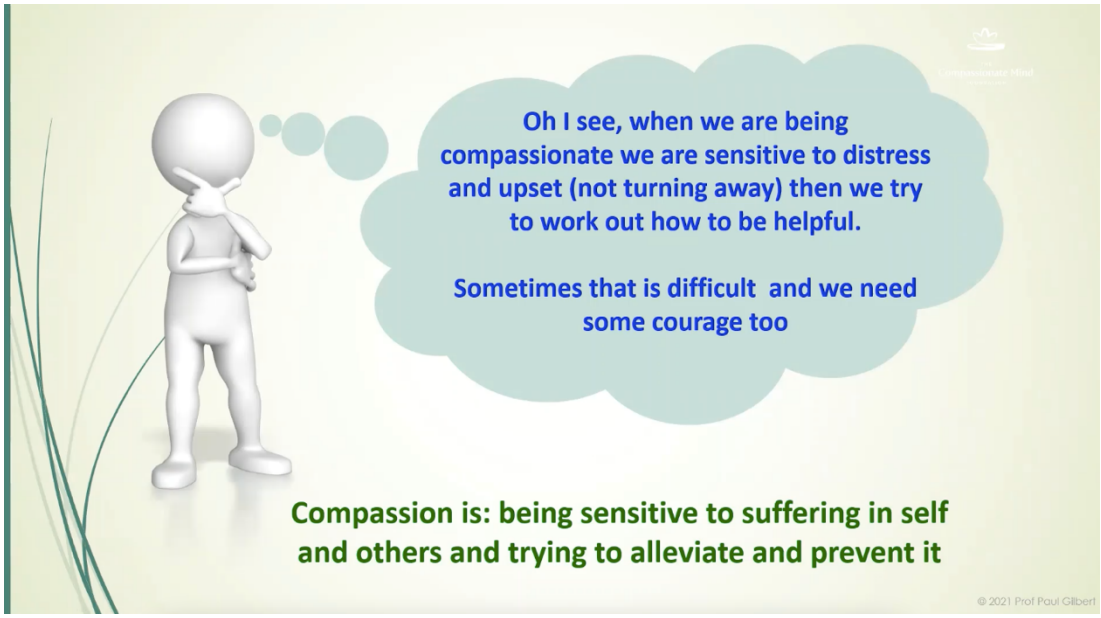
Psychoeducational Video Introducing Compassion


First, try to bring to mind a good friend and remember what you like about them
Now imagine that they are distressed because they have to go to hospital
© 2021 Prof Paul Gilbert


Oh No! I just received a letter to say that I have to go to hospital
I'm so frightened!
© 2021 Prof Paul Gilbert


I'm so frightened!
I CAN'T go to hospital
What can I do?!
I can understand that you are really upset because going to hospital can be frightening
Sensitive to their suffering
How can I be helpful? Maybe I could come with you
Working out ways to be helpful. Giving courage
© 2021 Prof Paul Gilbert


Very upset this has happened
We listen and try to understand. We are sensitive to their suffering
Then.....
We then try to work out ways to be helpful
Giving support
© 2022 Prof Paul Gilbert


Oh I see, when we are being compassionate we are sensitive to distress and upset (not turning away) then we try to work out how to be helpful.
Sometimes that is difficult and we need some courage too
Compassion is: being sensitive to suffering in self and others and trying to alleviate and prevent it
© 2021 Prof Paul Gilbert

Appendix G

Self-Compassion Intervention Script, adapted from Barrington (2022)

Excessive self-criticism can be associated with increased vulnerability to developing a range of difficulties e.g., low mood. However, research tells us that this can be moderated by self-compassion.

Self-compassion involves being warm and understanding toward ourselves when we suffer, fail, or feel inadequate, rather than ignoring our pain or being self-critical. Compassion-based therapies help people develop more positive ways of relating to themselves.

Today's study is focused on using virtual reality to help people practice and foster self-compassion. It will involve embodying an avatar in VR, delivering a short script focused on compassion to a distressed child avatar, and then re-embodiment of the distressed avatar. You will then hear a playback of your recording.

There are three components to giving a compassionate response. These will be outlined below with some examples that you can use to soothe the distressed child. We will practice these together before you enter the IVR.

1. **Validation**: Acknowledging the other person is upset and not judging them for feeling this way.

   “It’s not nice when things happen that we don’t like. It’s really made you feel bad about yourself, hasn’t it?”

2. **Redirection of Attention**: To direct the person’s attention to something more comforting and positive.

   “Sometimes when we feel bad about ourselves it’s helpful to think of someone who loves us and believes in us.”

3. **Memory Reactivation:** Suggesting the person elicits a memory of a soothing person, to evoke feelings of warmth and positivity.

   “What might they say to you now that would make you feel a bit better about yourself?”

Appendix H

Table Outlining Shapiro-Wilks Tests to Determine The Distribution of Outcome Variables

	Personalised	Non-Personalised
SCCS		
Self-Compassion Pre	$p = 0.316$	$p = 0.008$*
Self-Compassion Post	$p = 0.443$	$p = 0.036$*
Self-Criticism Pre	$p = 0.270$	$p = 0.297$
Self-Criticism Post	$p = 0.257$	$p = 0.191$
MBSRQ		
AE Change	$p = 0.041$*	$p = 0.346$
BASS Change	$p = 0.023$*	$p = 0.138$
VR Experience		
Presence	$p = 0.042$*	$p < .001$*
Adult Body Ownership & Agency	$p = 0.234$	$p = 0.445$
Child Body Ownership & Agency	$p = 0.053$	$p = 0.073$
Child Recognises Adult as Self	$p = 0.004$*	$p = 0.603$
Child Sense of Being Comforted	$p = 0.090$	$p = 0.502$

* denotes significant findings and deviation from normal distribution