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Virtual Reality-Induced Dissociative Symptoms: a Retrospective Study

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RESUMO

O uso de Realidade Virtual (RV) tem aumentado a nível mundial, à medida que as tecnologias se vão tornando mais sofisticadas e providenciam um escape à realidade durante a pandemia Covid-19. Este aumento recente no uso de RV tem conduzido ao relato de novos efeitos secundários, tais como sintomas dissociativos, que podem ou não constituir uma ameaça à saúde mental dos utilizadores. Este estudo retrospectivo teve como objetivo quantificar a prevalência e a intensidade dos sintomas dissociativos decorrentes da utilização de RV, bem como determinar potenciais fatores de risco que possam desencadeá-los ou amplificá-los, e ainda avaliar o impacto destes sintomas no bem estar do indivíduo. Os dados foram obtidos através de um questionário (N=358) colocado em grupos de Facebook dedicados a RV, que compreendeu uma versão modificada do *Clinician-Administered Dissociative State Scale* (CADSS) e questões direcionadas a fatores de risco reconhecidos como potenciais desencadeantes de experiências dissociativas. A análise estatística revelou que 83.9% dos participantes reportaram sintomas dissociativos, de intensidade variada de acordo com o CADSS ($\bar{X} = 7.62$; $s = 7.89$). Foram encontradas correlações significativas entre o CADSS *score* e o tempo passado em RV, o uso de aplicações que envolvem mãos virtuais ou *hand-tracking*, a presença de experiências dissociativas prévias, eventos traumáticos na infância, estratégias evitantes de *coping* e história de doença psiquiátrica. Não obstante, a maioria dos participantes classificou os sintomas como não-ansiógenicos (85.8%) e com uma duração de apenas minutos (77.4%). Em suma, este estudo revelou que embora a RV seja uma potencial indutora de experiências dissociativas, estas parecem ser de curta duração e inócuas para o bem estar do indivíduo, podendo ser antecipadas e atenuadas através do conhecimento e gestão de outros fatores de risco que possam desencadear fenómenos de dissociação.

Palavras-chave: Realidade Virtual; Dissociação; Despersonalização; Desrealização.

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ABSTRACT

The use of Virtual Reality (VR) has been increasing worldwide, as devices are becoming more sophisticated and provide an escape from reality during the COVID-19 lockdown. This recent rise in the use of VR leads to new side-effects being reported, such as dissociative symptoms that may or may not constitute a mental health concern. This retrospective study investigated the prevalence and intensity of dissociative symptoms in VR users, as well as some potential predisposing conditions that may trigger them, and their impact on the subjects' wellbeing. We conducted a survey (N=358) that was posted on VR Facebook groups. This survey comprised a modified version of the *Clinician-Administered Dissociative State Scale* (CADSS) and questions regarding potential risk factors known to induce dissociative disorders or experiences. Data analysis revealed that 83.9% participants reported dissociative symptoms, with varying intensity according to CADSS ($\bar{X} = 7.62$; $s = 7.89$). Significant correlations were found between CADSS score and the time spent playing, the use of software applications (apps) that involve virtual hands or hand-tracking, history of previous dissociative experiences, traumatic childhood events, avoidant coping strategies and psychiatric disorders. Nonetheless, most participants categorized the symptoms as non-anxiogenic (85.8%) and minute-lasting (77.4%). In conclusion, this study revealed that although VR can induce dissociative experiences, they seem to be short-lasting and non-threatening to the individual's wellbeing, and might be predicted or attenuated by managing other known risk factors for dissociative phenomena.

Keywords: Virtual Reality; Dissociation; Depersonalization; Derealization.

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ABBREVIATION LIST

CADSS: *Clinician Administered Dissociative States Scale*

DP/DR: *Depersonalization/Derealization*

VR: *Virtual Reality*

GLOSSARY

Avatar - an icon or figure representing a particular person in a video game

Depersonalization – a feeling of detachment from one’s body or mind

Derealization – a feeling of detachment from the real world, as if one is in a dream

Dissociation – the mental process of disconnecting from one's thoughts, feelings, memories or sense of identity

Head mounted display - a type of computer display device or monitor that is worn on the head or is built in goggles

Immersion (VR concept) - the objective ability of a system to provide sensorimotor stimuli that build human perception, making the experience feel realistic

Presence (VR concept) - the subjective experience of being in one place or environment, while being physically situated in another

Simulation - a situation or event that seems real but is not

Virtual Reality - a computer-generated simulation where the user interacts with an artificial three-dimensional environment using electronic devices, such as head mounted displays (goggles) or gloves fitted with sensors

- PART I -

BACKGROUND

In the last decades, the development of new sophisticated technologies has changed the way media are consumed, from photo, film and videogames, to the advent of Virtual Reality (VR) in the 1960s. VR can be defined as a computer-generated simulation where the user interacts with an artificial three-dimensional environment using electronic devices, such as head mounted displays (goggles) or gloves fitted with sensors. This technology possesses unique characteristics that sets it apart from older ones, namely a heightened sense of immersion and presence (Mütterlein, 2018).

Immersion usually refers to the objective ability of a system to provide sensorimotor stimuli that build human perception, making the experience feel realistic (O'Regan & Noë, 2001). High levels of immersion can be obtained with a high-resolution head-mounted display with head-tracking and full real-time motion capture, a wide field-of-view, and auditory and haptic feedback (Slater, 2018).

On the other hand, presence is the subjective experience of being in one place or environment, while being physically situated in another (Witmer & Singer, 1998), consisting of an illusion influenced by the level of immersion provided by a computation system.

These qualities make users feel like they can create and navigate within new believable realities, making VR the next big disruptive technology, with an estimate of 171 million users worldwide as of 2018 (Vailshery, 2021). Moreover, it has been expanding from the entertainment and gaming industry to other fields such as education, architecture design, tourism, aviation and maritime training, military training, disaster response training, surgical training, physical rehabilitation and medicine. When it comes to mental health, VR research is thriving in areas like pain management and a wide range of anxiety disorders (such as panic disorder and PTSD) and phobias, including fear of heights, social phobias, arachnophobia and fear of public speaking, among others.

Even though the most prominent quality of VR is its immersive potential, allowing it to simulate new realities and environments, it is known that highly absorbing virtual experiences can lead to a sense of detachment, a lowered sense of presence in the objective reality, and a consequential increase in depressive feelings (Kraut et al., 2002).

In fact, the human mind defines what is real and what is not based on sensory evidence. VR blurs that evidence, as the vivid visual and auditory sensory inputs that it provides aren't met with the corresponding external sensory inputs needed to establish the presented environment as fully real. Therefore, its users experience an illusion of embodiment through "consensual hallucinations"(Mantovani, 1995), that sometimes culminate in significant dissociative symptoms, such as prolonged difficulty in readjusting to the real world (Behr et al., 2005) and a feeling that the outside world isn't real (Searles, 2016) – posing moral, ethical and social concerns (Spiegel, 2018). This feeling of detachment from the real world, as if one is in a dream, is scientifically known as "Derealization".

Simultaneously, the use of virtual avatars whose hands or other body parts look different from the real ones, but move in synchrony with them (through the use of sensors and motion-capture) makes for a very realistic "perceptual correlation" that can induce a post-simulation feeling that a person's body is not his/her own anymore, or certain body parts don't feel his/hers (Spiegel, 2018) . This feeling of detachment from one's body or mind is known as "Depersonalization".

The phenomenon of embodiment and transferred body perception is not new, since it can be compared to the old "Rubber Hand Illusion": when a rubber hand placed in the participant's field of view is touched in synchrony with the participant's hidden hand, some individuals report that the rubber hand feels as if it were their own hand , which shows how easily body perception is deceived by visual inputs (Botvinick & Cohen, 1998). Virtual Reality has been used before to better reproduce this experiment and take advantage of its illusion to help decrease neuropathic pain in patients with spinal cord injury (Pozeg et al., 2017), or even stimulate mirror neurons that enhance the rehabilitation of stroke patients with hemiparesis - the virtual body or avatar is programmed to perform amplified movements that the patient will perceive as his own, consequently promoting neuroplasticity and restoring some aspects of the patient's movements (Tierl et al., 2018).

Despite the possible advantages and uses of dissociative phenomena in the treatment of some diseases, depersonalization and derealization symptoms aren't innocuous when it comes to a person's mental health.

While epidemiological surveys demonstrate that transient symptoms of depersonalization/derealization (such as daydreaming) are common in the general population, 1-2% of people reveal significant clinical manifestations that may integrate the diagnosis of Depersonalization/Derealization (DP/DR) Disorder (Hunter et al., 2004). When these symptoms become frequent or intense, they can cause significant distress and impairment in social, occupational, or other important areas of functioning, as well as a variable degree of anxiety and depressive symptoms motivated by the patients' feeling that they are "going crazy" or experiencing irreversible brain damage (American Psychiatric Association [APA], 2013).

Having highlighted the potentially harmful effects of depersonalization and derealization symptoms to a person's mental wellbeing, and knowing that, conceptually, VR has the power to induce those symptoms, it is natural to wonder whether VR is really safe for the use of the general population, and specially for people who have known risk factors for DP/DR disorder, such as a history of certain psychiatric and neurologic disorders, substance abuse, traumatic childhood events and avoidant coping strategies (APA, 2013).

Notwithstanding, to our knowledge, there is only one study to this date that directly tested VR's dissociative potential, with results showing an increase in symptoms of DP/DR following VR exposure, especially in those with initial higher levels of dissociative symptoms and a tendency towards immersion or absorption (Aardema et al., 2010).

Furthermore, we haven't found any studies addressing the prevalence and intensity of those symptoms in VR users, and whether they are influenced by the above-mentioned risk factors for DP/DR disorder, or even gameplay-related variables (such as the time spent playing or the use of particular apps).

Finally, we find it relevant to assess if these dissociative symptoms are perceived as anxiogenic and how long do they tend to last, in order to evaluate the real impact of these symptoms on the individual's mental wellbeing.

In summary, our study focuses on answering **3 different questions**:

- 1) What is the prevalence and degree of dissociative symptoms induced by VR?
- 2) How do individual and gameplay-related variables affect the extent of those symptoms?
- 3) What impact do the symptoms have on the subjects' mental wellbeing - are they anxiogenic? How long do they usually last?

We hope this investigation will be helpful in assessing the safety of the growing VR use among the population.

- PART II -

OUTCOMES

i. Primary Outcome

Assessing the prevalence and degree of VR-induced dissociative symptoms in VR users.

ii. Secondary Outcomes

- a) Analyzing how different variables impact the extent of those symptoms, such as:
- Individual variables: previous dissociative experiences, history of psychiatric/neurologic disorders or traumatic childhood events and avoidant coping strategies. These are known risk factors for dissociative disorders, according to the DSM-V.
 - Gameplay-related variables: time spent playing, use of particular apps (namely apps that include fake hands or hand tracking) and degree of immersion/presence.
- b) Assessing if the dissociative symptoms were perceived as anxiogenic and how long they tended to last, in order to evaluate the real impact of these symptoms on the individual's mental wellbeing.

These outcomes may help evaluate the safety of the use of VR devices by the general population.

- PART III -
METHODS

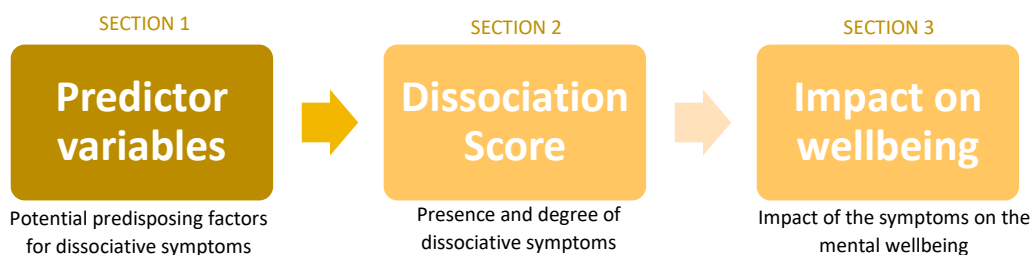
i. Study sample

This study was based on an online survey directed at self-selected English-speaking VR users. Participants who reported being under 18 years old or who refused to give informed consent for data collection and analysis were automatically excluded from the study. Potential applicants weren't told that the survey concerned dissociative symptoms prior to starting it, and weren't offered any monetary incentives.

The ideal sample size was estimated at 300-400 participants, with a confidence level of 95% and a significance level of 5%. The survey was posted on 5 VR Facebook groups (with a total of 324 thousand members) and accepted answers between February and August 2021, having registered a total of 358 answers. Of the 358 participants who completed the survey, 19 (5.3%) were excluded due to incoherencies in their answers, and 5 (1.4%) for failing to provide informed consent, resulting in a total of 334 effective participants.

ii. Data Collection

The questionnaire was elaborated on Google Forms and was divided in 3 sections, one for the primary outcome (section 2), and one for each of the secondary outcomes (section 1 and 3).



SECTION 1 – Predictor variables

The first set of questions (Q2-Q9) regarded gameplay-related variables and individual variables that could predispose to dissociative experiences, comprising the following topics:

a) Gameplay-related variables

- time spent using VR (frequency of sessions and time per session)
- use of particular apps, such as those that include fake hands or hand tracking (simulating the “rubber hand illusion”)
- degree of immersion/presence.

To our knowledge, the correlation between these variables and the degree of VR-induced dissociative symptoms was never tested.

b) Individual variables

- history of psychiatric disorders: dissociative identity disorder, DP/DR disorder, dissociative amnesia, generalized anxiety disorder, PTSD, panic disorder, depression and schizophrenia;
- history of neurologic disorders: epilepsy, migraine, vertigo, Meniere’s disease and CNS neoplasm;
- history of traumatic childhood events;
- substance use (cannabis, hallucinogens, MDMA, ketamine and *Salvia*);
- self-reported avoidant coping strategies;
- history of dissociative experiences.

These are known risk factors for dissociative disorders or experiences, according to the DSM-V and Kaplan and Sadock’s comprehensive textbook of Psychiatry (Sadock, 2017).

SECTION 2 – Dissociation Score

This section (**Q10-Q28**) comprised an adapted version of the *Clinician-Administered Dissociative State Scale* (CADSS) (Bremner et al., 1998), a validated clinical tool that assesses and quantifies present-state dissociative symptoms on 3 different spheres: depersonalization, derealization and dissociative amnesia.

It is a 27-item scale with 19 subject-rated items and 8 items scored by an observer. Since it was applied through an online survey, we left out the 8 observer-related questions, which doesn't affect validity since the subjective part of the CADSS, by itself, has shown high internal consistency (coefficient alpha =.94) and high interrater reliability (Intraclass correlation coefficient=.99) (Bremner et al., 1998).

The 19 subject-rated questions regard various types of sensations that can be experienced in dissociative states, and the answers range from 0 (not at all) to 4 (extremely). The total score is calculated by the sum of all the 19 answers, ranging between 0 and 76 points.

Participants were told that if they had experienced those sensations more than once (after using VR), they should answer the questions having in consideration the episode where they felt them the most. Therefore, the questions were transformed from present-state to past-state, for better understanding.

The total CADSS score was used to assess the prevalence and degree of VR-induced dissociative symptoms.

SECTION 3 – Impact on mental wellbeing

The final section (**Q29-Q31**) involved 3 questions, with the purpose of assessing:

- If the symptoms induced anxiety;
- How long those symptoms lasted;
- If the participants had ever experienced similar symptoms before.

The first two questions were used to calculate the real impact of the dissociative symptoms on the subjects' lives. The final question was only placed in this section for better understanding, as it is meant to be part of the "predictor variables" (section 1).

iii. Data Analysis

Primary outcome

Prevalence and intensity of dissociation symptoms

The total CADSS score was obtained by the sum of each of the 19 items from section 2.

A descriptive statistical analysis was performed to determine the prevalence of dissociative symptoms among VR users (CADSS score ≥ 1), as well as the extent of those symptoms (given by the score's mean and standard deviation).

Secondary outcomes

Predictor Variables

The correlations between each of the predictor variables and the total CADSS score were determined using independent-samples t-test (for nominal variables) and Spearman's correlation coefficient (for ordinal variables). Significance was set at the ≤ 0.05 level.

Impact on mental wellbeing

A descriptive statistical analysis was performed to assess the duration and anxiogenic potential of the dissociative symptoms. Independent-samples t-test was used to assess the association between anxiety symptoms and CADSS score. Spearman's coefficient was used to assess the correlation between the duration of symptoms and CADSS score. We also performed a Likelihood Ratio Chi-Square test to look for an association between symptom duration and anxiety symptoms.

- PART IV -

RESULTS

i. Prevalence and degree of dissociative symptoms

A total of 280 participants reported some kind of VR-induced dissociative symptoms (CADSS score ≥ 1), adding up to a prevalence of 83,9%.

Nonetheless, most of them reported an overall mild degree of those symptoms, having achieved relatively low CADSS scores, although with some variability ($\bar{X} = 7,62$; $s = 7,89$). The lowest reported score was 0, and the highest was 53 (in a total of 76 points).

A visual representation of frequency distribution is displayed in the histogram in Figure 1.

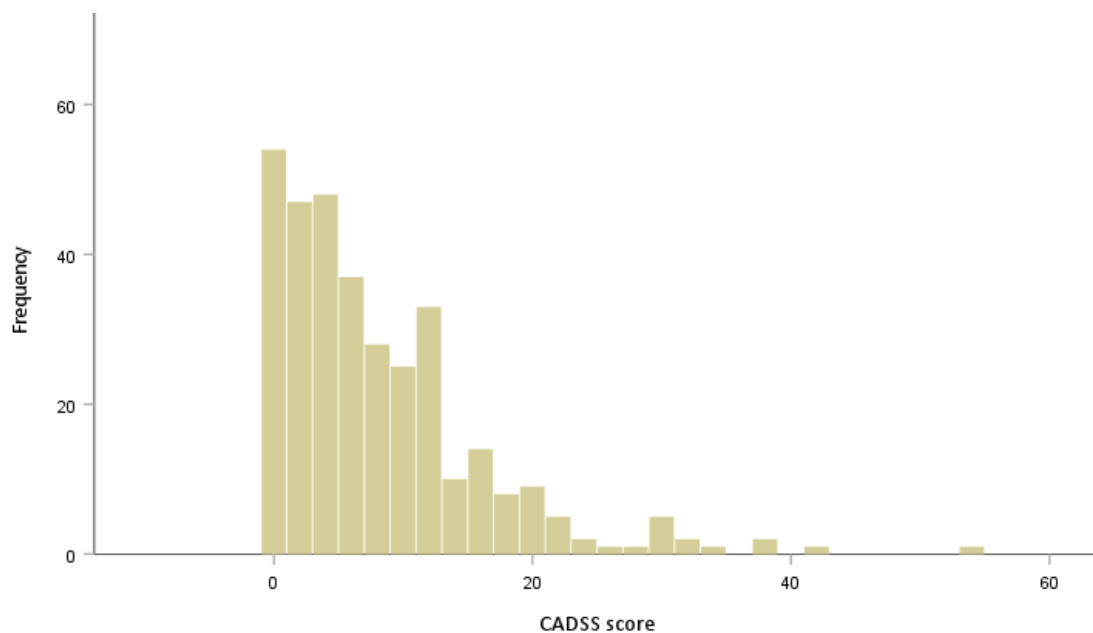


Fig.1 – Frequency distribution of CADSS score – the histogram shows a non-normal distribution that is skewed right, with most participants reporting a low degree of dissociative experiences.

ii. Correlation between predictor variables and dissociation score

Participants who reported playing more than 1 hour per session and using apps where they have virtual hands or hand-tracking showed significantly higher CADSS scores, as well as those who reported previous dissociative experiences, traumatic childhood events, avoidant coping strategies and history of psychiatric disorders, particularly Generalized Anxiety Disorder.

On the other hand, no significant correlation was found between CADSS score and the frequency of VR use, the level of immersion, substance use and history of neurologic disorders.

Independent-samples t-test and Spearman's correlation results are presented on Table 1 and Table 2, respectively.

		Mean ± St.Deviation	t value	Sig. (1-tailed)
Time per session	>1h	8.16 ± 8.28	t = 2.382	p = .009
	<1h	6.09 ± 6.49		
Virtual hands/hand-tracking apps	Present	8.17 ± 8.00	t = 2.644	p = .005
	Absent	5.58 ± 7.13		
Psychiatric disorders	Present	9.57 ± 9.06	t = 2.718	p = .003
	Absent	6.93 ± 7.33		
Generalized anxiety disorder	Present	11.30 ± 10.81	t = 3.260	p < .001
	Absent	6.85 ± 7.16		
Neurologic disorders	Present	8.00 ± 7.92	t = .271	p = .394
	Absent	7.58 ± 7.73		
Traumatic childhood events	Present	12.05 ± 10.26	t = 4.816	p < .001
	Absent	6.55 ± 7.16		
Substance use	Present	8.38 ± 8.06	t = 1.036	p = .151
	Absent	7.38 ± 7.32		
Avoidant coping strategies	Present	8.56 ± 8.49	t = 1.983	p = .024
	Absent	6.82 ± 7.27		
Previous dissociative experiences	Present	12.61 ± 9.03	t = 2.077	p = .021
	Absent	9.54 ± 7.84		

Table 1 – Predictor Variables - Independent-samples t-test results

	Spearman's rho	Sig.
Frequency of VR use	$r_s = -.077$	$p = .161$
Immersion level	$r_s = .083$	$p = .128$

Table 2 – Predictor variables - Spearman's correlation test results

iii. Impact on mental wellbeing

Only 14,2% of participants categorized the dissociative symptoms as anxiogenic (see Figure 2). Those participants revealed a significantly higher CADSS score (15.74 ± 11.83), when compared to the others (9.39 ± 7.14) ($t = 4.115$, $p < .001$).

In accordance, the majority of participants reported a relatively short symptom duration, with 77,4% of the answers pointing towards “minutes”. Only 0,5% of participants reported long lasting symptoms (“months”). Frequency distribution is displayed in Figure 3.

Participants who reported longer symptom duration also revealed significantly higher dissociation scores ($r_s = .150$, $p = .014$, $N = 217$) and anxiety symptoms ($G^2(4, N = 217) = 14.261$, $p = .007$).

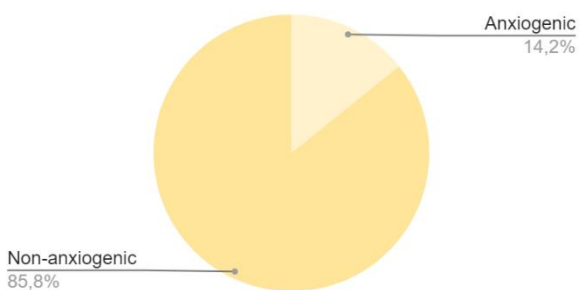


Fig.2 – Frequency distribution of symptom-induced anxiety

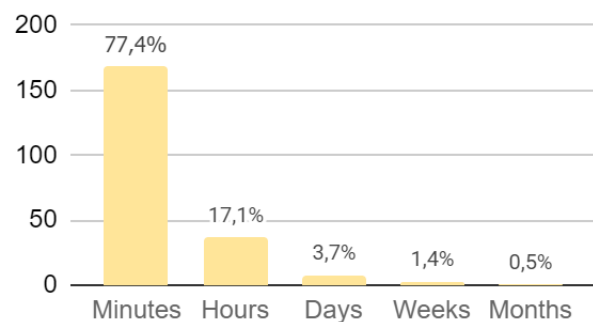


Fig.3 – Frequency distribution of symptom duration

- PART V -

DISCUSSION

Virtual Reality is a rapidly evolving technology that created new horizons for human perception and new ways to challenge our beliefs of what reality is.

Dissociative experiences are a natural aftermath of the increasingly blurred limits between reality and fiction, and they may have unpredictable effects on the users' mental health, calling into question the safety of these devices for the use of the general population.

Therefore, this study had the purpose of testing that safety, under three scopes: determining how prevalent and intense the dissociative symptoms are; studying what variables can trigger or enhance them; and investigating how they affect the users' mental wellbeing.

Prevalence and intensity of VR dissociative symptoms

In line with the initial hypothesis and previous literature (Aardema et al., 2010), we found a high prevalence of dissociative symptoms among VR users. Even though most participants revealed a relatively low intensity of symptoms, there was still a high variability and range of symptoms among users, which needs to be considered when questioning the safety of VR for the global population. This variability could be partially explained by the gameplay and individual variables that we studied, which could help discriminate which players are more susceptible to dissociative experiences.

How gameplay variables impact dissociation

Although most participants revealed a relatively low intensity of symptoms, we found that some gameplay-related variables may influence the intensity of those symptoms: the users who reported playing more than 1 hour per session and using apps that include virtual hands or hand-tracking showed significantly higher dissociation scores. This makes sense, since users who spend more time continuously in the virtual world, and who choose games where fake hands trick the mind just like the "Rubber hand" (Botvinick & Cohen, 1998), are constantly giving their body the visual clues it needs to believe that the virtual environment has some realness to it, while at the same time it lacks some of the elements of perception such as touch. This disconnection between visual and tactile signs is known to induce dissociative experiences by altering the perception of the "self" (Ehrsson, 2007) (Ionta et al., 2011) (Lenggenhager et al., 2007)

(Lenggenhager et al., 2009). Simultaneously, VR also affects the vestibular function, since the visual and somatosensory signals it provides about body position and motion are constantly conflicting with signals from the inner ear regarding the real body orientation. In fact, the vestibular symptoms that it causes are so well known that they have their own name – *cybersickness*.

The perceptual incoherence arising from the vestibular interpretation is known to distort bodily self-consciousness as well (Lopez, 2013). In fact, dizziness and ear caloric stimulation by themselves are able to induce out of body experiences (Lopez & Elzière, 2018)(Yen Pik Sang et al., 2006). As such, it is expected that the longer the body is receiving these conflicting signals between vision, touch and vestibular system, the greater the possibility of triggering dissociative symptoms.

On the other hand, the frequency/regularity of VR use and the level of immersion described by the users didn't seem to impact the intensity of dissociative symptoms. As for the former, we can hypothesize that the regularity of sessions doesn't affect perception of reality as much as the time spent in each session because the body gets to readjust to the objective reality between each set. As for the latter, it goes against previous knowledge, since previous literature showed that a tendency towards immersion or absorption related significantly to the level of VR dissociative symptoms (Aardema et al., 2010). More studies are needed to clarify this matter.

How individual variables impact dissociation

In line with our hypothesis, we found that participants who had a history of previous dissociative experiences, traumatic childhood events, avoidant coping strategies and psychiatric disorders showed significantly higher dissociation scores. This comes as no surprise, since all of these are known predisposing factors for DP/DR disorder according to the DSM-V. These findings suggest that people who are at risk for dissociative disorders should be more careful when considering using VR devices, especially for longer periods of time.

Nonetheless, it is interesting to notice that the psychiatric disorder that led to the highest post-VR dissociation scores was Generalized Anxiety Disorder. In a time when

VR is being increasingly used to provide exposure therapy for anxiety-spectrum disorders (Parsons & Rizzo, 2008)(Botella et al., 2017)(Carl et al., 2019), we can hypothesize that having dissociative experiences (that could themselves be anxiogenic) as a possible side effect of VR therapy, could, in turn, exacerbate the patient's anxiety symptoms.

On the other hand, although we found differences in the dissociation scores of people who use substances and those who don't, and people who have neurological diseases and those who don't, those differences weren't statistically significant.

As for substance use, we hypothesize that maybe more importantly than using drugs or not, is the regularity of that use, which we didn't account for, to keep the survey as simple as possible. The timing of the drug use (in relation to the time of the VR session) could also be important. We suggest that future studies regard this matter.

The lack of correlation we found between dissociation score and the selected neurological diseases (that are known risk factors for dissociative experiences) might be attributed to the fact that we had a short sample of these patients (N=28), leading to a lack of statistical power.

Impact of symptoms on mental wellbeing

Even though the prevalence of dissociative symptoms was high among VR users, they didn't seem to have a big impact on the subjects' lives, since they were generally non-anxiogenic and short lasting.

Unsurprisingly, the participants who reported more intense and longer-lasting symptoms were also the ones who revealed anxiety towards those symptoms.

Since we proved that users who had predisposing factors for dissociation showed a higher intensity of dissociative symptoms, we can thereby assume that these individuals also have longer lasting and anxiety-inducing symptoms, with potential hazards to their mental wellbeing.

Therefore, individuals who have known risk factors for dissociative disorders should be precautionous when using VR, since they are more prone to experiencing symptoms that can jeopardize their mental health.

A limitation of the present study is that it relies on self-report assessment, which we attenuated by removing answers that were contradictory or incoherent. This study also had a time gap that could potentiate a memory bias, since patients reported complex experiences that may have occurred months or even years ago.

We recommend that future studies on this matter should be done in a prospective manner, to avoid the memory bias, and to better study the mechanisms behind dissociative VR experiences and their potential contributes and risks for human health and wellbeing.

- PART VI -

CONCLUSION

With this study, we concluded that although VR has the potential to trigger dissociative experiences, in the majority of cases they are mild, non-anxiogenic and short-lasting, making them apparently innocuous to the user.

Nonetheless, more severe and durable effects can happen in people who have a predisposition for this kind of experiences. Besides treating and avoiding preventable risk factors, these people should also focus on playing for shorter periods of time, and avoiding apps that include hand-tracking or other features that trick the circuits of body perception.

Furthermore, a special caution must be taken when using VR for therapeutical purposes in patients with psychiatric disorders (specially anxiety disorders), since this population is not only more prone to experiencing dissociative effects, but also to suffer the worst consequences from those effects, leading to a paradoxical aggravation of their initial symptoms.

On the other hand, VR's dissociative potential can also be used to our advantage, as it has been done in the treatment of certain neurological disorders such as neuropathic pain and hemiparesis. We hope the present study will help weighting the risks and benefits of VR therapeutical use in each patient, allowing for a better candidate selection.

With the ongoing technological evolution, Virtual Reality will keep challenging our body and mind in unexpected ways. We hope the future will unlock its full potential and open a new chapter in the study of the human mind and how it perceives reality and fiction.

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ATTACHMENTS - Questionnaire

VR-induced Dissociative Symptoms

The present Informed Consent informs all research participants, in a clear and unequivocal way, about the process of data collection and processing regarding the study "Virtual Reality-induced Dissociative Symptoms". This retrospective study aims to quantify the prevalence and degree of dissociative symptoms in healthy VR users, as well as determining predisposing or potential risk factors that may contribute to it.

Your participation in this study is completely voluntary and it's based on the gathering of information from the adult population (18 years and older) through a survey that will take about 10 minutes. By agreeing to participate in this study, you are asked to answer truthfully all the questions that will be presented to you.

All the information collected will be confidential and will only be used for research purposes. Any information obtained as part of this study that you can identify will be confidential and will not be disclosed without your prior permission. All data collected will be stored in a way that allows conformity with the Portuguese and European Union legislation concerning data protection and privacy. All personal data will be stored separately from the data resulting. This will be ensured by appropriate technical and organizational measures.

Measures will be taken to protect personal data against accidental or unlawful destruction or accidental loss, alteration, unauthorized disclosure or access. As part of a risk mitigation policy, data backup and recovery procedures will be implemented to protect data.

At the end of the project, all participants' personal data will be deleted.

The study does not involve any potential risks, whether social, legal, or financial.

You are informed that you may withdraw at any time and that if you have any questions throughout the research you may contact the responsible team at the e-mail address: mariana.taveira@campus.ul.pt

*Obrigatório

1. I declare that I have read the Informed Consent to voluntarily participate in this research: *

Marcar apenas uma oval.

I declare that I am over 18 years old, I HAVE READ and ACCEPT to voluntarily participate in the investigation.

I declare that I have read and DO NOT ACCEPT to voluntarily participate in the investigation.

Section 1 – Predictor Variables

VR-induced Dissociative Symptoms

Welcome to this survey! First, we kindly ask you to answer some questions about yourself and your VR experience.

2. How frequently do you use VR? *

Marcar apenas uma oval.

Every day

Every week

Every month

Rarely

3. When you use VR, for how long do you use it: *

Marcar apenas uma oval.

Less than 1 hour per session

More than 1 hour per session

4. When you use VR, how immersed do you feel? *

Immersion is the perception of being physically present in the virtual environment

Marcar apenas uma oval.

1 2 3 4 5

Not at all Completely immersed

5. Do you usually use apps where you have virtual hands OR hand-tracking (like the Climb, Elixir, Venues, Superhot...)? *

Marcar tudo o que for aplicável.

- Yes
 No

6. Do you have a clinical diagnosis of any of the following psychiatric disorders? *

Marcar tudo o que for aplicável.

- Depersonalization/Derealization Disorder
 Dissociative Identity Disorder
 Dissociative Amnesia Disorder
 Generalized Anxiety Disorder
 Panic Disorder
 Post-Traumatic Stress Disorder
 Depression
 Schizophrenia
 I have experienced traumatic situations during my childhood (such as violence or abuse)
 None of the above

7. Do you have a clinical diagnosis of any of the following neurological disorders? *

Marcar tudo o que for aplicável.

- Epilepsy
 Migraine
 Vertigo
 Meniere's Disease
 Brain Tumor
 No

8. Do you regularly use any of the following substances? *

Marcar tudo o que for aplicável.

- Cannabis
 MDMA/Ecstasy
 Hallucinogens (LSD, PCP, Mescaline, Psilocybin - "Magic Mushrooms")
 Ketamine
 Salvia divinorum
 No

9. Do you have an innate tendency to avoid or deny dealing with difficult/stressful situations, feelings or thoughts? *

Marcar apenas uma oval.

- Yes
 No

Section 2 – Adapted CADSS Questionnaire

VR-induced Dissociative Symptoms

After using VR (specially for the first time), some people experience weird sensations such as feeling like their hands are not their own, or like the world around them is different or less real. These last 19 questions regard various types of sensations that you may have experienced after using VR. If you have experienced them more than once, please choose the answer that applies to the episode where you felt that sensation with the most intensity.

10. After using VR, did things ever seem to be moving in slow motion? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed slightly slowed down, but not very noticeable.
- Moderately, things were moving about twice as slow as normally.
- Severely, things were moving so slowly that they were barely moving.
- Extremely, things were moving so slowly, I had the perception that everything had come to a stop, as if time was standing still

11. After using VR, did things ever seem to be unreal to you, as if you were in a dream? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed a little unreal, but I was well aware of where I was at.
- Moderately, things seem dreamlike, although I knew I was awake.
- Severely, things seemed very dreamlike, although I knew that I was here, I had the feeling like I might have been asleep.
- Extremely, I felt like nothing was real, like I should pinch myself to wake up, or ask someone if it was a dream.

12. After using VR, did you ever have the experience that something was separating you from reality ; for instance, did you ever feel as if you were in a movie or a play, or as if you were a robot? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I felt a little bit separated from what was happening, but I was basically there.
- Moderately, I felt somewhat separated from what was going on, or I felt as if I was in a movie or a play.
- Severely, I felt extremely separated from what was happening, but I could understand what people were saying.
- Extremely, I felt as if everyone around me was talking a foreign language, so that I could not understand what they are saying, or I felt as if I was on the outside looking in, or like I was a robot or a machine.

13. After using VR, did you ever feel as if you were looking at things from outside of your body? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I felt somewhat disconnected from myself, but I was basically all together.
- Moderately, I felt like I was just outside of my body, but not looking down upon myself from far above.
- Severely, I felt like I was twenty feet or more away from my body, looking down from above.
- Extremely, I felt as if I was hundreds of feet above myself, looking down at myself and everyone else here.

14. After using VR, did you ever feel as if you were watching your life as an observer or a spectator? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I felt slightly detached from what was going on, but I was basically here.
- Moderately, I felt somewhat removed as an observer or a spectator, but I was definitely in this room.
- Severely, I felt very much as if I was an observer or a spectator, but I was still here in this room.
- Extremely, I felt completely removed from what was happening, as if I was not a part of that experience in any way, but totally removed from what was happening, as an observer or a spectator.

15. After using VR, did you ever feel disconnected from your own body? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I felt a little bit disconnected from myself, but I was basically all here.
- Moderately, I felt somewhat detached from my own body, but I was basically all together.
- Severely, I felt detached from my own body, but not far removed from my body, and I felt as if it was me there.
- Extremely, I felt like I was completely out of my body, as if I was looking at my own body from a long way off, as if there was another person there.

16. After using VR, did your sense of your own body feel changed: for instance, did your own body feel unusually large or unusually small? Or did your hands ever feel like they were not your own? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I had a vague feeling that something about my body had changed, but I can't say exactly what it is.
- Moderately, I felt like my body had increased or decreased in size slightly, or that it felt somewhat as if it was not my body/hands.
- Severely, I felt as if my body had increased to twice its normal size, or decreased to twice its normal size, or I very much felt as if that was not my body/hands.
- Extremely, I felt as if my body had swelled up to at least ten times its normal size, or as if it was ten times as small, or as if my arms had become like toothpicks.

17. After using VR, did other people ever seem motionless, dead, or mechanical? *

Marcar apenas uma oval.

- Not at all.
- Mildly, people seemed a little bit more motionless, dead, or mechanical than would be normal.
- Moderately, people seemed to be at least twice as motionless or mechanical than would be normal.
- Severely, people seemed to be barely moving, or barely alive, or very mechanical.
- Extremely, it's as if everyone were frozen or completely like machines.

18. After using VR, did objects ever look different than you would expect? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed slightly different than normal, although it was barely perceptible.
- Moderately, things were somewhat distorted, but I had no problems recognizing things around me.
- Severely, things were much more distorted or unreal than normal, but I was able to recognize things in the room.
- Extremely, like everything was distorted, not real, I felt like I couldn't recognize anything, everything was alien or strange.

19. After using VR, did colors ever seem to be diminished in intensity? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed slightly paler than usual if I think about it.
- Moderately, colors were somewhat diminished, but still recognizable.
- Severely, colors were extremely pale, in no way as vivid as they usually are.
- Extremely, as if everything was in black and white, or all the colors had been washed out.

20. After using VR, did colors ever seem much brighter than you would have expected? *

Marcar apenas uma oval.

- Not at all.
- Mildly, colors seemed a little bit brighter than normal, but not more than twice as bright.
- Moderately, colors seemed brighter, about twice as bright as normal.
- Severely, colors seemed very bright, at least five times as bright as normal.
- Extremely, colors seemed extremely bright, almost fluorescent, at least 10 times as bright as normal.

21. After using VR, did you ever see things as if you were in a tunnel, or looking through a wide angle photographic lens? *

Marcar apenas uma oval.

- Not at all.
- Mildly, I felt a little bit like I was looking through a tunnel, or a wide angle lens.
- Moderately, the periphery of my vision was blacked out, but I still had most of my visual field, or things are somewhat like a wide angle lens.
- Severely, it seemed as if I was looking through a tunnel, or through a wide angle lens, but I could see everything clearly.
- Extremely, as if I was looking through a pair of binoculars backwards, where everything around the periphery was blacked out, and I could see a little point of light at the end of a tunnel, with little tiny people and objects, or I was seeing things as if through a wide lens and things were incredibly expanded.

22. After using VR, have sounds ever almost disappeared or become much stronger than you would have expected? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things were either a little quieter than normal, or a little louder than normal, but it was not very noticeable.
- Moderately, things became about twice as soft as normal, or twice as loud as normal.
- Severely, things became very quiet, as if everyone was whispering, or very loud (although not deafening).
- Extremely, things became completely silent, or sounds were so loud that it was deafening, and I felt as if I was going to break my eardrums.

23. After using VR, did things ever seem very real, as if there is a special sense of clarity? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed to be a little bit more real than normal.
- Moderately, things seemed to be more real than normal.
- Severely, things seemed to be very real or have a special sense of clarity.
- Extremely, things seemed to have an incredible sense of realism or clarity.

24. After using VR, did it ever seem as if you were looking at the world through a fog, so that people and objects appeared far away or unclear? *

Marcar apenas uma oval.

- Not at all.
- Mildly, things seemed somewhat foggy and unclear, or I had the feeling that things were far away, but there was not a major effect on how I perceived things around me.
- Moderately, things seemed very foggy and unclear, or things seemed like they were far away, but I could identify the people and objects in the room easily.
- Severely, I could barely see things around me, such as the people and the objects in the room.
- Extremely, I could not make anything out around me.

25. While you were experiencing those weird sensations, did that experience seem to be taking much longer than you would have expected? *

Marcar apenas uma oval.

- I didn't experience any weird sensations
- Not at all.
- Mildly, it seemed as if it had gone on for at least twice as long as the true elapsed time.
- Moderately, it seemed as if it had gone on for at least two hours.
- Severely, it seemed as if it had gone on for at least ten hours.
- Extremely, it seemed as if time was standing still, so that we have been here at this point in time forever.

26. While you were experiencing those weird sensations, did things seem to be happening very quickly, as if there was a lifetime in a moment? *

Marcar apenas uma oval.

- I didn't experience any weird sensations
- Not at all.
- Mildly, things were happening slightly faster than normal.
- Moderately, things seemed to be happening at least twice as fast as normal.
- Severely, things seemed to be happening at least 10 times faster than normal.
- Extremely, as if that whole experience had happened at once, or as if there was a lifetime in a moment.

27. Have there been things which have happened during that experience that now you can't account for? *

Marcar apenas uma oval.

- I didn't experience any weird sensations
- Not at all.
- Mildly, there may have been things which happened which now I can't account for, but nothing pronounced.
- Moderately, at least once there were things which happened which now I can't account for.
- Severely, at least twice I have lost several minutes of time, so that now there are things I cannot account for.
- Extremely, large pieces of time are missing, of ten minutes or more, so that I am confused about what has happened.

28. Have you spaced out, or in some other way lost track of what was going on during that experience? *

Marcar apenas uma oval.

- I didn't experience any weird sensations
- Not at all.
- Mildly, I have had some episodes of losing track of what is going on, but I have followed everything for the most part.
- Moderately, I have lost at least a minute of time, or have completely lost track of what is going on now.
- Severely, I have lost several segments of time of one minute or more.
- Extremely, I have lost large segments of time of at least 15 minutes or more.

Section 3 – Impact on mental wellbeing

VR-induced
dissociative
symptoms

In this final section, we ask you to answer 3 final questions concerning the sensations that you felt. If you answered "None of the above" to all 19 questions from the previous section, please select "I didn't feel any weird sensations" in these final questions.

29. Did those sensations make you feel anxious or stressed? *

Marcar apenas uma oval.

- Yes
- No
- I didn't feel any weird sensations

30. How long did those sensations last (on average)? *

Marcar apenas uma oval.

- Minutes
- Hours
- Days
- Weeks
- Months
- Years
- I didn't feel any weird sensations

31. Had you ever experienced those sensations before using VR for the first time? *

Marcar apenas uma oval.

- Yes
- No
- I didn't feel any weird sensations