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Psychological benefits of using social virtual reality platforms during the covid-19 pandemic: The role of social and spatial presence

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ABSTRACT

Social virtual reality (VR) platforms are an emergent phenomenon, with growing numbers of users utilizing them to connect with others while experiencing feelings of presence ("being there"). This article examines the associations between feelings of presence and the activities performed by users, and the psychological benefits obtained in terms of relatedness, self-expansion, and enjoyment, in the context of the covid-19 pandemic. The results of a survey conducted among users ($N = 220$) indicate that feelings of spatial presence predict these three outcomes, while social presence predicts relatedness and enjoyment, but not self-expansion. Socialization activities like meeting friends in VR are associated with relatedness and enjoyment, while playful and creative activities allow for self-expansion. Moreover, the perceived impact of social distancing measures was associated with an increase in use, suggesting the utility of these platforms to help users meeting particularly frustrated psychological needs. These results provide a first quantitative account of the potential positive effects of social VR platforms on users' wellbeing and encourage further research on the topic.

1. Introduction

Throughout the last few years, the availability of virtual reality (VR) systems with good quality and affordable prices, and their progressive adoption by the public, have paved the way for the proliferation of social VR platforms (Gaggioli, 2018). Inspired by previous experiences of social virtual worlds, such as Second Life, a plethora of VR social networks has emerged in the last few years: platforms such as VRChat, AltspaceVR, or Rec Room, among others, allow users to embody in an avatar and to get immersed in a three-dimensional virtual environment, where they can interact with other users in real-time. Compared to other media technologies, the most distinctive aspect of these applications is that they rely on the use of immersive technology (VR headsets), which makes them able to elicit a strong illusion of presence in users, i.e., a feeling of *being there* (Hartmann & Fox, 2020; Slater & Sanchez-Vives, 2016), inside the virtual world, physically sharing the same space with other people.

Communities of people are often born around a shared physical space (Silk, 1999), and the physical immediacy of others is a central component of the feeling of social presence (Oh, Bailenson, & Welch, 2018; Short, Williams, & Christie, 1976). By offering (virtual) spaces where users can hang out, chat, and play games together in apparent physical proximity, social VR apps could be especially well-suited to foster feelings of social connection among users (e.g., Maloney & Freeman, 2020). This potential may be particularly beneficial in a context of social distancing measures (e.g., lockdown of public spaces, obligation to stay home) as the ones enforced to combat the covid-19 pandemic. As the name reveals, social distancing aims to drastically reduce people's physical proximity to each other. However, social contact and relatedness are central human needs (Baumeister & Leary, 1995; Deci & Ryan, 2012), and social distancing can have detrimental effects on people's psychological wellbeing (Fiorillo & Gorwood, 2020; Galea, Merchant, & Lurie, 2020; Holmes et al., 2020). Unsurprisingly then perhaps, usage data of social VR platforms tentatively suggest that users adopted these applications to overcome the psychological burden imposed by social distancing measures: according to Steamcharts (www.steamcharts.com), the number of concurrent users of AltspaceVR increased by 79.21% at the onset of the Covid-19 pandemic, during March 2020, and by 57.75% in April 2020, whereas the average monthly increase during the previous year (from March 2019 to February 2020) was only of 1.39%. Likewise, VRChat, whose monthly increase in users in the previous year was only 1.9%, experienced increases of 18.63% and 23.90% during March and April 2020, respectively.

Previous research has extensively investigated the reasons for, and

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the psychological benefits obtained from, the use of social virtual worlds, like Second Life (e.g., Hassouneh & Brengman, 2014; Partala, 2011; Zhou, Jin, Vogel, Fang, & Chen, 2011). However, only recently researchers started to explore users' motivations for using social VR (e.g., Freeman & Maloney, 2021; Maloney & Freeman, 2020; Sykownik, Graf, Zils, & Masuch, 2021). No research has yet –to the best of our knowledge-addressed in a quantitative way the psychological benefits that users gain from the use of social VR platforms, and how feelings of presence contribute to these psychological benefits. Understanding this facet is not only relevant to expand our knowledge of the uses of social VR platforms, but also for guiding the industry towards designing related VR applications that are accepted and adopted by users. Moreover, examining the use of social VR platforms seems particularly relevant in the times of the covid-19 pandemic. Some scholars recently hinted at the potential of traditional media and VR to alleviate the psychological impact of social distancing measures (e.g., Riva & Wiederhold, 2020; Wiederhold, 2020) - but, to date, the benefits obtained from the use of social VR platforms in this context have not been analyzed.

Accordingly, the present study aims to shed further light on the psychological benefits of highly immersive social VR platforms, also in the covid-19 context. In what follows, we report the results of an online survey conducted among users that provides insights into these questions, and we discuss the relevance of our results for the scientific understanding of this new type of tool for mediated social interaction.

2. Theoretical background

2.1. Social VR platforms and feelings of presence

Social VR platforms are "3D virtual spaces where multiple users can interact with one another through VR head-mounted displays" (Maloney & Freeman, 2020, p. 510). They have also been defined as "applications that enable geographically remote users to interact with each other in shared virtual environments through VR technology, i.e., immersive head-mounted displays" (Sykownik et al., 2021, p. 537). At the present time, several online VR applications with a social component exist (cf. Tanenbaum, Hartoonian, & Bryan, 2020), with diverse characteristics and functionalities.

Probably the closest non-VR referent for social VR platforms is Second Life (Gaggioli, 2018) - a multi-user, three-dimensional online *virtual world* that allows users to create their own avatars and use them to interact with other users, objects, and places. Launched in 2003 by the company Linden Lab, Second Life was very well received by the public: just a few years later, it had about 1.1 million users, although user numbers declined again afterwards (Axon, 2017). Unlike (most) online games, Second Life does not define clear goals for users, but it relies on the spontaneous actions or activities performed by users (e.g., exploring virtual places, socializing with other users, meeting new people, trading with virtual products, or attending user-generated events, among others). Most current social VR platforms have this in common with Second Life. Although some of them have a very specific focus, such as, for instance, the shared watching of video streaming (e.g., Bigscreen) or playing games with a spatial component (e.g. playing paintball in Rec Room), most of the new VR platforms can be considered *general-purpose* social VR networks that, rather than focusing on any specific activity, allow for social interactions between users through a variety of activities and virtual environments. The fundamental idea of platforms like VRChat or AltspaceVR is that users, embodied in their own avatars (Fig. 1), may explore different worlds and meet other users, chat and hang out with them, and take part in social activities such as games or virtual events (e.g., attending concerts, conferences, or even religious services). These platforms also rely on user-generated content to a large extent: users can generate (e.g., thematic) virtual worlds, and launch users-driven events and activities in these environments (e.g., open-mic nights, LGTBQ supports groups, meditation trainings, in AltspaceVR).

Existing social VR platforms share as a basic communicational affordance with Second Life that users interact with each other using their avatars, in real-time. In light of the affordances suggested by Fox and McEwan (2017), social VR platforms and social virtual worlds like Second Life offer synchronous interactions, allowing for *personal* (i.e. the messages are directed to specific individuals or groups, rather than broadcasted) and *private* (users control who receives the message) forms of communication, with a high degree of *conversational control* (e.g., users can start or end an interaction at any given moment) and *network connectivity* (users can interact with physically distant others). Since interactions occur in real-time, they are not *persistent* (interactions are normally ephemeral -although they could be recorded by users) nor *editable* (interactions cannot be modified once they occurred). Within this common set of affordances, slight variations exist among social VR applications. For example, some platforms (e.g., VRChat) allow for a higher level of *anonymity* (e.g. using a nickname, which may be changed) than others (e.g., in Facebook Horizon, users' avatars are linked to their Facebook profile).

However, the key aspect differentiating social VR platforms from more traditional virtual worlds like Second Life is that they are designed to be primarily accessed using a VR head-mounted display (HMD). This technology blocks the perception of the real environment, and provides an immersive environment instead that responds naturalistically to users' actions (e.g., when users turn their head, the perspective of the environment changes). As a consequence, social virtual reality platforms like AltSpace or Facebook Horizon differ from traditional screen-based social virtual worlds like Second Life in at least two aspects.

First, social VR platforms can foster a strong sense of *presence* in users, that is, of feeling fully embodied and physically located in the virtual environment. Particularly VR-supported user-tracking, the use of stereoscopic visuals, and wider fields of view enhance presence experiences (Cummings & Bailenson, 2016). Presence can be considered a largely automatically generated and mostly sensory-driven perceptual sensation or feeling that is introspectively accessible (Haans & IJsselsteijn, 2012; ISPR, 2001; Lee, 2004; Wirth et al., 2007). Scholars commonly distinguish spatial, social, and self-presence (e.g., Lee, 2004). In short, spatial presence refers to users' sense of being physically located in, and enveloped by, the virtual environment, which also

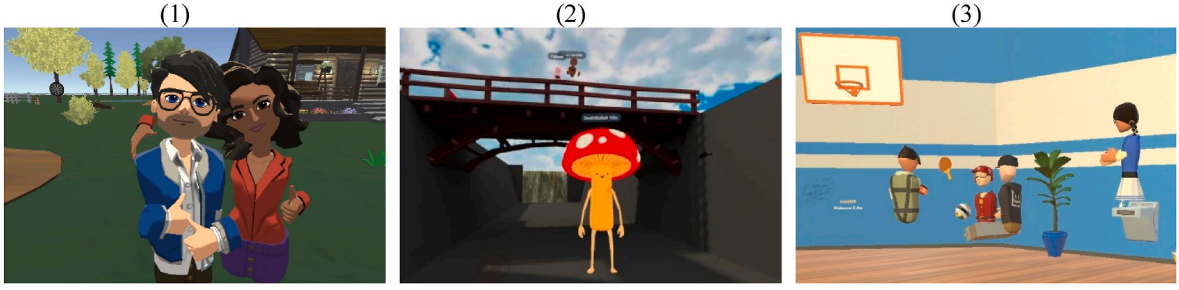

Fig. 1. Examples of users' avatars in AltspaceVR (1), VRChat (2), and Rec Room (3).

implies that displayed objects appear to be physically co-located and existing (Wirth et al., 2007). Closely related, social presence refers to users' sensation of being physically co-located and socially connected with social others (Biocca, Harms, & Burgoon, 2003; Oh et al., 2018). While less immersive media like smartphones or screen-based social apps also allow to access other people's minds or respond to the "presence of another mind", social VR platforms add to this the "presence of body" (Biocca et al., 2003). Closely related again, self-presence refers to users' perceiving the virtual body as their actual body (Kilteni, Groten, & Slater, 2012). In social VR, users can momentarily feel ownership over the virtual body of their avatar, and experience their virtual self as their actual self. This might not only affect social interaction in VR, as "our avatars change how we interact with others" (Yee & Bailenson, 2007, p. 272), but also motivate users to process and judge the overall social situation differently than, e.g., in screen-based media, as in social VR users can feel as if their actual physical body was involved and exposed. Accordingly, in VR, threats to the virtual body can be experienced as threats to one's actual physical body (Kilteni et al., 2012). Relatedly, scholars suggest that proximity or personal space violations in social encounters are more stressful in VR than in screen-based social applications (Wilcox, Allison, Elfassy, & Grelik, 2006). In summary, social VR platforms are unique due to their offered mix of spatial, social, and self-presence. Using the terminology of affordances discussed by Fox and McEwan (2017), social VR platforms therefore particularly provide stronger *social presence* affordances ("the feeling that interactants are near and sharing the same experience together"; p. 302) than traditional platforms, since users perceive others as being physically close and like sharing the same physical space.

Second, VR-based applications also allow interacting with the provided virtual environment, virtual objects, and avatars of other users in a very intuitive way (e.g., users can approach and talk to each other, like in the physical world, while the avatar reproduces users' body movements and gestures in real-time). Unlike Second Life (which is accessed via a computer), the use of HMDs (which track users' head and hand movements) therefore provide *embodied* social interactions that mimic face-to-face interactions in the physical world to a large extent (Bailenson, 2018; Maloney & Freeman, 2020). Using the terminology of affordances discussed by Fox and McEwan (2017), social VR platforms therefore provide greater *bandwidth* ("the breadth of social cues potentially transmitted in a channel"; Fox & McEwan, 2017, p. 302) than screen-based media, because users can use gestures and proxemics (e.g., getting physically close to others, even whispering in their ears), which broaden the range of available social cues.

2.2. Psychological benefits derived from using social VR platforms

Diverse theoretical perspectives, like uses and gratifications (U&G, Katz, Blumler, & Gurevitch, 1973; Ruggiero, 2000), and selective exposure (Luong & Knobloch-Westerwick, 2021) theories acknowledge the role of media use for the fulfillment of various users' psychological needs. Accordingly, why do users adopt and turn to social VR platforms? Whereas research addressing this question only started to emerge (Sykownik et al., 2021), a number of studies explored the psychological benefits that users obtain from screen-based virtual worlds, and particularly Second Life (see Table 1). This research focuses on users' motivation for using these platforms (e.g., Hassouneh & Brengman, 2014; Shelton, 2010; Zhou et al., 2011), and on the psychological needs that users satisfy through usage (e.g., Barnes & Pressey, 2011; Partala, 2011). Table 1 provides a summary of this research, showing a variety of motivations for, and psychological needs satisfied with, the use of Second Life.

Taking this evidence (particularly, on the typologies of users' motivations; Zhou et al., 2011) as a starting point, scholars recently tried to illuminate why users adopt social VR platforms. Based on a qualitative study, Sykownik et al. (2021) identified four types of motivations driving social VR use, namely *social* ("social needs addressed by or the social benefits that result from establishing and maintaining interaction with other users", p. 541), *self-related* ("benefits for personal identity, mental health, and personal development […] motives and needs related to the *Self*", p. 542), *experiential* ("needs that are addressed and benefits that arise from the sole experience of social VR usage […] benefits such as entertainment, excitement, playfulness, and escapism", p. 541), and *functional* ("purposeful, task-related benefits derived from the completion of previously defined tasks", p. 542). It is important to note that these four motivations do not necessarily perfectly match the actual benefits that users derive from social VR use (cf. Palmgreen, Wenner, & Rayburn, 1980), as both what users seek and what they obtain from these platforms might differ. However, if the benefits derived from using a medium would consistently fail users' motivations, users likely experience dissatisfaction, causing them to eventually stop usage (Bae, 2018). Hence, the motivations identified by Sykownik et al. (2021) might reliably hint also at the psychological benefits that users regularly obtain from social VR platforms. More specifically, the social, self-related, and experiential motivations identified by Sykownik et al. seem to hint at important psychological benefits that users derive from their VR platforms usage, while the functional motivation seems to link to instrumental use of social VR that, so far, seems to only play a minor role (Sykownik et al., 2021).

Table 1
Summary of studies on drivers of the use of second life.

Study	Drivers of the use of Second Life
Barnes and Pressey (2011)	Psychological needs: belonging, esteem, and self-actualization
Hassouneh and Brengman (2014)	Motivations: friendship; escapism; role-playing; achievement; relationships; manipulation
Partala (2011)	Psychological needs satisfied: Autonomy; competence; relatedness; self-actualization/ meaning; physical thriving; pleasure/ stimulation; money/luxury; security; self-esteem
Shelton (2010)	Motivations: Identity customization, fantasy, and role-playing); Social/Entertainment (escapism, relationship, relaxation, and socialization); Achievement (advancement/ challenge and competition)
Verhagen, Feldberg, van den Hooff, Meents, and Merikivi (2012)	Motivations: extrinsic motivation ("perceived usefulness"); intrinsic motivation ("entertainment value")
Zhou et al. (2011)	Motivations: social (e.g., "socializing", "romance"), functional (e.g., "learning", "doing business"), and experiential (e.g., "entertainment", "getting away from real life") motivations

2.2.1. Presence and relatedness

The preeminence of social motivations (Sykownik et al., 2021) is consistent with previous research on Second Life (Hassouneh & Brengman, 2014; Partala, 2011; Zhou et al., 2011) and suggests that the use of social VR can help users satisfy their psychological need for relatedness, that is, the need for establishing meaningful and rich social interactions, which is considered a fundamental human psychological need (Deci & Ryan, 2012). Similar to Second Life, social VR platforms allow users to connect and interact with distant others in real-time, and to perform a variety of activities together, which, naturally, can help the formation of social bonds (Altman & Taylor, 1973). However, as compared to classic virtual worlds, social VR platforms allow for more natural social interactions with seemingly physically co-present others.

Embodied accounts of social cognition (cf. Barsalou, 2008) suggest a strong metaphorical association between physical sensations and psychological concepts (Bargh, Schwader, Hailey, Dyer, & Boothby, 2012). In particular perceptions of physical closeness to others might increase perceptions of psychological and social closeness (Williams & Bargh, 2008). In this respect, early qualitative reports suggest that the illusion

of physical closeness to others in social VR applications may enhance the perception of social closeness and intimacy with them (Maloney & Freeman, 2020; Zamanifard & Freeman, 2019). For instance, in a study conducted by Maloney and Freeman (2020), a long-distance couple reported that sleeping next to each other in a social VR app (i.e. with their avatars placed next to each other in the virtual space, while their physical bodies are in distant locations) make them "feel closer to each other" (p. 514). Hence, the feeling of being physically placed in a virtual space (i.e., spatial presence) in the company of others (i.e., social presence) could help develop relatively intimate and close relationships. Since the perception of closeness and intimacy with others is intrinsically associated with the satisfaction of social affiliation and relatedness needs (e.g., Patrick, Knee, Canevello, & Lonsbary, 2007), we hypothesize that:

H1. Feelings of spatial presence (H1a) and social presence (H1b) will predict the satisfaction of the need for relatedness in users of social VR platforms.

2.2.2. Presence and the self

Existing qualitative research stresses that some of users' central motivations for using social VR platforms are related to exploring and experimenting with their own identity, and enacting versions of themselves different from those of the physical reality. Social VR offers users a safe space (Maloney & Freeman, 2020) where they can adopt an appearance (e.g., tailored avatars) and behavior that they would not adopt in the physical world, in a variety of ways. For example, users might be inclined to explore others' perspectives (e.g., how it feels to adopt a different body), behave differently than they do in physical reality (e.g., users feeling physically restrained experiencing to fly, users with social anxiety practicing their social skills), and expressing their true self (e.g., transgender users experimenting with gender-conforming avatars before they transition; Freeman, Zamanifard, Maloney, & Adkins, 2020; Freeman & Maloney, 2021; Sykownik et al., 2021).

The psychological benefits of these various ways of experimenting with the self can be explained from the temporarily expanding the boundaries of the self (TEBOTS) perspective (Johnson, Ewoldsen, & Slater, 2015; Slater, Johnson, Cohen, Comello, & Ewoldsen, 2014). This perspective argues that being oneself inherently imposes efforts of self-regulation, identity maintenance, and limitations to the satisfactions of the primary psychological needs (competence, autonomy, and relatedness) described in self-determination theory (Deci & Ryan, 2012). People may therefore turn to media to "manage threats to and limitations of self-concept […], not necessarily through escapism […], but rather through expansion—a merging of self and other that allows for expansion of the possibilities of human experiences […] while retaining the ontological sense of self" (Johnson, Slater, Silver, & Ewoldsen, 2016, p. 388).

The TEBOTS framework mainly focuses on how people engage in media narratives to vicariously experience how it feels to be another one (a different, expanded version of oneself), which helps release the tensions of maintaining the own identity in everyday life. These benefits are, however, not necessarily restricted to the use of media narratives, but they can also be present when using media with social components. The fact that role-playing is one of the main motivations for the use of social virtual worlds like Second Life (Hassouneh & Brengman, 2014) points in this direction.

Moreover, the immersive properties of VR should make the experimentation with other selves more compelling and effective (Hartmann & Fox, 2020). Diverse theoretical approaches acknowledge that the self is not a unitary concept, but it encompasses different components (Comello, 2019). Already James (1890/1981) distinguished between the *I*, understood as the subject who perceives and experiences the self, and the *me*, that is the self as an object of experience. The *me* includes aspects as the material self (the perception of one's body), the social self (how others perceive the self), and the spiritual self (the self-perception of the own psychological aspects, such as feelings or interests). Similarly, Riva (2018) argues that the integration of the body into the self occurs at different levels, including physical levels (the *sentient* and *core* selves, i.e. "the phenomenological experience of the body", p. 244) and more conceptual levels (the autobiographical self, "the reflective knowledge about the body", p. 244). The core, physical experience of the body includes the experience of being in the space and controlling one's own body actions (Riva, 2018).

Users report a more intimate connection between their physical body and their digital self in social VR, compared to less immersive platforms (Freeman & Maloney, 2021). Furthermore, VR users interact with a social environment that responds to their movements in real-time, which (unlike other technologies with disembodied forms of interaction) might more strongly alter how they experience their material self (Cohen, Appel, & Slater, 2020). Hence, both spatial and social presence might affect users' self-expansion in various ways. When using social VR platforms to explore different versions of themselves -or to *expand the boundaries of the self*-feelings of presence might enhance not only users' explorations of their social self, but also of their material, core self and its boundaries. Hence, we hypothesize the following:

H2. Feelings of spatial presence (H2a) and social presence (H2b) will predict feelings of self-expansion experienced by users of social VR platforms.

2.2.3. Presence and entertainment

Users also approach social VR applications in their search for entertainment, playfulness, and pastime activity (Sykownik et al., 2021). The wide range of playful activities (from paintball in RecRoom to performing in a karaoke night in AltspaceVR) that users can engage in on many social VR platforms also suggest entertainment-related, hedonic, outcomes from social VR use. Theories of selective exposure (e.g., Knobloch-Westerwick, 2006) suggest that entertainment-related uses of media serve to regulate emotional states and, in this respect, social VR can be particularly well-suited to help users overcoming boredom by offering activities that may enhance arousal (e.g., playing games), trigger curiosity (e.g., exploring virtual worlds), or prompt creativity (e.g., worlds or avatar creation). Hence, together with socialization and self-expansion outcomes, avoiding boredom or seeking fun may also be a significant benefit obtained from social VR use. That is, the use of social VR platforms might also provide benefits in terms of entertainment, above and beyond fulfilled social affiliation or self-expansion needs (e.g., when users engage in solitary use, or do not experiment with different versions of themselves).

Accordingly, previous research shows that users of virtual world like Second Life usually seek arousing and stimulating experiences when using them (Barnes & Pressey, 2011; Partala, 2011). In the case of social VR applications, feelings of presence may contribute to making the experience more arousing and fun for users. The illusion of presence makes the experience more vivid, *as if* the represented events were really (physically) happening (Slater & Sanchez-Vives, 2016), and previous research on immersive media suggest that feelings of presence can contribute to making the experience more entertaining (Hartmann & Fox, 2020). Indeed, feelings of spatial presence (Barreda-Ángeles, Aleix-Guillaume, & Pereda-Baños, 2020a; Barreda-Ángeles et al., 2020b; Vettehen, Wiltink, Huiskamp, Schaap, & Ketelaar, 2019) have been associated with greater enhanced arousal and enjoyment of media narratives, whereas social presence is also a predictor of reported enjoyment in diverse media settings, like live streaming of events (Shin, Song, Kim, & Biocca, 2019) or videogame playing (Gajadhar, De Kort, & Ijsselsteijn, 2008). Our third hypothesis is, thus:

H3. Feelings of spatial presence (H3a) and social presence (H3b) will predict feelings of enjoyment in users of social VR platforms.

2.3. Activities performed and beneficial psychological outcomes

Social VR platforms offer users a large variety of possible activities, and, naturally, engaging in one or another type of activity determines

the psychological outcomes that users obtain from their experience. Sykownik and colleages (2021) collected open-ended descriptions of the activities performed by users of different platforms and identified three typologies or clusters of activities: socializing (e.g., hanging out with others), entertainment (e.g., gaming, content creation), and working/learning (e.g., learning sign language) activities. Most users reported activities related to socialization or entertainment, while only four (out of 195) users reported working or learning activities. What has not been explored so far is whether and to what extent different activities contribute to actual benefits in terms of feelings of relatedness, self-expansion, and enjoyment of the experience. Therefore, we raise the following research question:

RQ1: How do the activities performed in social VR platforms predict feelings of relatedness, self-expansion, and enjoyment?

2.4. The covid-19 context

Research on Second Life (Partala, 2011) shows that virtual worlds are often used to satisfy psychological needs that users experience in their daily lives outside the virtual world. In this regard, and as suggested by usage data reported above, a contextual aspect that is likely to impact the use of social VR platforms is the enforcement of social distancing measures due to the Covid-19 pandemic. These measures might have effectively thwarted basic needs of belonging by cutting down relevant social contacts, triggering a need for self-expansion by restricting individuals to the limited space of their home, and increasing boredom, and hence the motivation to seek diversity and entertainment. The social-distancing measures enforced during the covid-19 pandemic might have therefore enhanced the motivational basis of using social VR as a functional alternative to other, no longer available, options. This might have driven users to focus on those activities that help satisfy particularly unmet needs, therefore affecting the psychological outcomes obtained by them. Results of the qualitative study conducted by Sykownik et al. (2021) suggest that users found social VR platforms particularly attractive during a lockdown (e.g., "it's especially nice during quarantine to get to talk to others while feeling like you're really in the world there with them", Sykownik et al., 2021, p. 541). However, the specific impact of the social distancing measures on the activities performed by users, and the psychological benefits derived from them, have not been explored, which lead us to pose the next research question:

RQ2: How did the context of social distancing measures during the covid-19 pandemic affect the activities performed by users of social VR, and the psychological outcomes derived from them?

3. Method

3.1. Sample and procedure

An English online survey was administered in May and June 2020. The survey targeted users of any social VR platform and was posted in related forums in Reddit, Facebook groups, and Discord channels related to social VR in general, and to specific social VR platforms like VRChat, AltspaceVR, or Rec Room. Since previous research on this topic is very limited, we did not have a predefined sample size, but we use a convenience sample size, based on the number of responses obtained in this period. A total of 339 volunteers took the survey, but, after removing incomplete responses, the final (convenient) sample was limited to 220 participants (completion rate: 65%). The sample included 170 males and 44 females (plus six participants whose reported gender was *Other/Not listed*), aged from 12 to 65 ($M = 27.44$; $SD = 12.57$; four participants did not report their age). The most common geographical location of the participants was the USA (126 participants, 57% of the sample), followed by the UK (20 participants, 9%), and Canada (11 participants, 5%). The rest of the participants were from European countries other than the UK (39 participants), Latin-American countries (eight participants), Australia (six participants), and Asian countries (five participants). The remaining five participants did not report their location. The majority of the participants (n = 206, 94%) reported that social distancing measures had been enforced in their country from more than a month ago at the moment of taking the survey.

All participants reported being users of at least one social VR platform. Most of them (n = 168, 76%) used only one, while 28 participants (13%) used two different platforms, 15 participants (7%) used three platforms, and the remaining 9 participants (4%) used more than three. The most commonly reported social VR platform was VRChat (137 participants, 62%), followed by Rec Room (73 participants, 33%), and AltspaceVR (50 participants, 23%). Other platforms used by fewer participants were, for instance, High Fidelity, Wave, or BigScreen. The most commonly used type of device for accessing these platforms were high-end VR headsets (e.g., Oculus Rift or similar; 139 participants, 63%), followed by intermediate devices like Oculus Quest (n = 54, 25%), with the rest of participants using low-end devices (e.g., mobile VR) or accessing content on a laptop or desktop computer. Regarding previous use, 120 participants (55% of the sample) reported they used a social VR platform for more than a year already, 32 participants (15%) between six months and a year, another 41 (19%) between one and six months, and 26 participants (12%) less than one month (one participant did not report previous use). Finally, a majority of 147 participants (67%) used social VR applications three times per week, while 51 participants used them between one and three times per week (23%), and 16 participants (11%) only "a few times" per month, or "very occasionally" (n = 6, 3%). Looking at these results, the sample was skewed towards heavy users of social VR platforms: the *typical* participant represented in our sample was an "early adopter" (more than 1 year of use), using rather powerful VR devices (e.g., Oculus Rift), and revealing a relatively intense use of more than three times per week.

3.2. Measures

The following measures were included in the survey. Except where otherwise specified, users were asked to report their level of agreement with each of the items of each measurement on a five-point Likert-type scale, ranging from *Strongly disagree* to *Strongly agree*.

Spatial presence. The four items of the self-location subscale of the Spatial Presence Experience Scale by Hartmann et al. (2016) were used as a measure of spatial presence. Examples of the items used are: *When I use Social VR platforms, I feel like I am actually there in the virtual environment*; *When I use Social VR platforms, it is as though my true location shifts into the virtual environment.* Cronbach's α of the spatial presence scale was 0.80.

Social presence. An adapted version of the Networked Minds Social Presence Inventory by Harms and Biocca (2004) was used as a measure of social presence. The original scale contains 36 items, measuring six factors (6 items per factor). Due to space restrictions, we selected the three items with the highest load per factor (according to Harms & Biocca, 2004), leading to an adapted scale of 18 items. Examples of the items used are: *When I use Social VR platforms, the other users' presence is obvious to me; When I use Social VR platforms, I can tell how the other users feel*. This scale also showed a good reliability (Cronbach's $\alpha = 0.82$).

Relatedness. This was measured with four items designed to assess the satisfaction of the need of relatedness from the Basic Psychological Need Satisfaction and Frustration Scale (Chen, Vansteenkiste, et al., 2015; Chen, Van Assche, Vansteenkiste, Soenens, & Beyers, 2015). Examples of the items used are: *When I use Social VR platforms, I feel connected with people who care for me, and for whom I care*; *When I use Social VR platforms, I feel close and connected with other people who are important to me*. This scale provided very good reliability (Cronbach's $\alpha = 0.92$).

Self-expansion. An adapted version of the *boundary expansion* scale by Johnson et al. (2016) was used to measure the satisfaction of the need to expand the boundaries of the self. The original scale measures self-expansion as a single factor and it consists of 11 items, addressed to

measure three second-order factors (three items for each of the two first second-order factors, and four items for the third second-order factor). In order to limit the duration of the present survey, we removed the item with the lowest loading per second-order factor reported in the original study (Johnson et al., 2016), resulting in a seven-item scale, which we used to measure self-expansion as a single factor, as in the original article (Johnson et al., 2016). Examples of the remaining items are: *When I use social VR platforms, I experience facing situations and challenges other than those in my own life*; *When I use social VR platforms, I experience what it is like to be someone else*. The reliability of this scale was good (Cronbach's $\alpha = 0.80$).

Enjoyment. We adapted the three items from the fun scale by Oliver and Bartsch (2010), which has been used previously to measure enjoyment of VR experiences (e.g., Lin, Wu, & Tao, 2018), to the use of social VR platforms. The items used were: *When I use social VR platforms, I have a good time; When I use social VR platforms, I find it entertaining*; *When I use social VR platforms, it is fun*. The observed reliability of this scale was very good (Cronbach's $\alpha = 0.91$).

Activities. Participants reported, on a five-point scale ranging from *never* to *very often*, the frequency with which they perform each of the following activities on social VR platforms: *chatting with friends; meeting new people*; *playing games*; *exploring virtual worlds*; *creating new things (new worlds, avatars, etc.)*; and *attending virtual events (concerts, exhibitions, etc.)*. This list was an adapted version of the list of common activities in Second Life provided by Partala (2011), modified according to the researchers' own perceptions of common activities in social VR platforms (e.g., removing items such as "organizational activities").

Self-perceived impact of the social distancing measures. Participants were asked to report the impact of the social distancing measures on their daily lives by choosing one among the following options: *very little or no impact (there is no change -or almost no change-on my daily life)*; *moderate impact (there are some relevant changes in my daily life)*; or *severe impact* (*my daily life changed drastically*).

Increase in use. Participants were asked to report whether their use of social VR platforms had increased after the beginning of the Covid-19 outbreak, by choosing among the options: *Yes, a lot more*; *Yes, a little more*, or *No*.

3.3. Data processing and analysis

Prior to analyses, missing values in multi-item scales (about 0.25% of the total items) were imputed by the mean of the remaining items. Afterwards, in order to verify the adequacy of our measurement model, an exploratory factor analysis (EFA) was conducted on the items of the relatedness, self-expansion, and enjoyment scales, using the *psych* package (Revelle, 2020) in *R*, with ML estimation and "oblimin" rotation. This EFA yielded a three-factor solution, reported in Table 2. As shown in the table, the three factors corresponded to the three scales employed, and most of the items loaded on their corresponding factor. However, two items (items 5 and 6) of the self-expansion scale had similar loading across factors. A plausible explanation for this is that, although the self-expansion scale was validated as providing a one-factor solution, it also features a second-order factor structure (Johnson et al., 2016), representing the classic three dimensions of self-determination theory (relatedness, autonomy, competence; Deci & Ryan, 2012). Items 5 (*When I use social VR platforms, I experience what it is like to relate others in ways different than I normally do*) and 6 (*When I use social VR platforms, I experience getting to know people I would never otherwise know*) both refer to the relatedness dimension, and therefore they also plausibly loaded on the relatedness factor, next to the self-expansion factor (item 6 loaded on the enjoyment factor as well). Given the lack of unique loadings for these two items, they were removed in subsequent analyses.

Table 2
Results of the exploratory factor analysis for gratifications.

		F1	F2	F3
Relatedness	Item 1	**0.81**	−0.01	0.06
	Item 2	**0.99**	0.00	−0.06
	Item 3	**0.90**	0.00	0.02
	Item 4	**0.68**	0.02	0.17
Self-expansion	Item 5	0.31	0.40	−0.02
	Item 6	0.11	0.17	0.24
	Item 7	−0.10	**0.68**	0.17
	Item 8	0.03	**0.79**	−0.01
	Item 9	0.16	**0.58**	−0.03
	Item 10	0.03	**0.72**	−0.06
	Item 11	−0.11	**0.69**	−0.01
Enjoyment	Item 12	0.03	0.01	**0.90**
	Item 13	−0.03	−0.04	**0.87**
	Item 14	0.04	0.04	**0.83**
Eigenvalues		3.18	2.66	2.47
Variance explained		0.23	0.19	0.18
Variance explained (cumulative)		0.23	0.42	0.59

Notes. Factor loadings equal or higher than 0.50 are highlighted in bold.

The data of the remaining items was submitted to a confirmatory factor analysis (CFA), conducted with the package *lavaan* (Rosseel, 2012) in *R*, which showed that the three-factor solution provides a good fit to data, χ^2 (51) = 141.24; $p < .001$; CFI = 0.95; RMSEA = 0.09, 90% CI [0.07, 0.11]; SRMR = 0.06, thus validating our measurement model (Hu & Bentler, 1999).

We then extracted the factor scores for further use in subsequent analyses. Multiple methods for factor scores calculation exist, including non-refined and refined methods, with different properties (DiStefano, Zhu, & Mîndrilă, 2009). While refined methods yield more exact estimates, they provide scores in the form of standardized scores (DiStefano et al., 2009), that is, with a mean of 0 per factor, which do not allow for direct comparisons between factors. To be able to compare among factors and also to benefit from the better properties of refined methods, we calculated both non-refined factor scores (that we used to compare the intensity of the different factors in the sample), as well as refined factor scores (that we used in all other analyses). Non-refined factors scores were estimated simply by calculating the mean values of the items of each scale (DiStefano et al., 2009), and an ANOVA test was conducted to examine differences on the intensity of the factors. Refined scores were calculated using the Bartlett method as implemented in the *lavaanPredict* function within the *lavaan* package in *R*. A structural equation models was then used to test the hypotheses. RQ1 was also tested using a structural equation model, while a chi-square test and multiple regressions were used to test RQ2.

4. Results

4.1. Presence and psychological outcomes of use

Overall, users reported feeling a relative strong sense of spatial ($M = 3.73$, $SD = 0.95$, on five-point scale) and social ($M = 3.50$, $SD = 0.51$) presence when using social VR platforms. Regarding psychological benefits, the absolute values of the non-refined factor scores (see Fig. 2), ranging from 3.40 ($SD = 0.96$) for self-expansion, to 4.58 ($SD = 0.59$) for enjoyment, on a scale ranging from 1 to 5, suggest that the three psychological benefits are present to a large extent in the use of social VR platforms. The results of a repeated-measures ANOVA with Greenhouse-Geisser correction showed statistically significant differences between the levels of the three outcomes, F (1.75, 382.98) = 140.38; $p < .001$; $\eta^2_G = 0.24$. Subsequent pairwise t-tests with Benjamini-Yekutieli correction (Benjamini & Yekutieli, 2001) indicated that all three gratifications significantly differed from each other; relatedness vs. self-expansion: t (219) = 7.49; $p < .001$; $d = 0.63$; relatedness vs. enjoyment: t (219) = 9.37; $p < .001$; $d = 0.69$; self-expansion vs. enjoyment: t (219) = 17.6; $p < .001$; $d = 1.48$. Taken together, these results suggest that the use of social VR platforms is most effective in providing enjoyment to users, followed by relatedness and self-expansion outcomes.

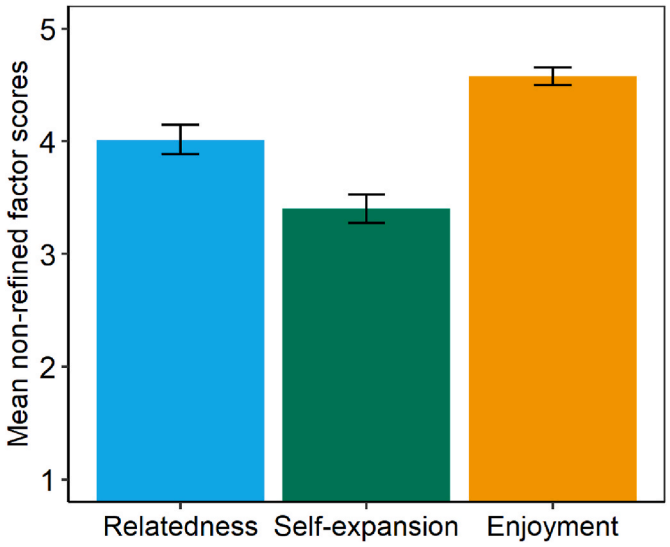

Fig. 2. Mean non-refined factor scores for the three beneficial psychological outcomes.

To test hypotheses 1 to 3, on the association between spatial and social presence and the three psychological benefits, we fitted a saturated structural equation model with *lavaan* (Rosseel, 2012), represented in Fig. 3. H1 forecasted that feelings of spatial presence (H1a) and social presence (H1b) would predict the satisfaction of the need for relatedness in users of social VR platforms. The model shows that, indeed, stronger spatial and social presence are associated with more intense feelings of relatedness, providing support to the two sub-hypotheses within H1. Our second hypothesis (H2) proposed that spatial presence (H2a) and social presence (H2b) would predict feelings of self-expansion experienced by users of social VR platforms. The results (Fig. 3) show that spatial presence is a significant predictor of self-expansion, which supports H2a. However, social presence is not a significant predictor of self-expansion. Therefore H2b is not supported. Finally, H3 forecasted that feelings of spatial presence (H3a) and social presence (H3b) would predict users' feelings of enjoyment. Results fully support this hypothesis.

In summary, the model shows that feelings of spatial presence are associated with the three outcomes, while social presence is only a relevant predictor of experienced relatedness and enjoyment, but not of self-expansion. The coefficients of the regression paths suggest that social presence, compared to spatial presence, is more strongly associated with relatedness and enjoyment obtained from the use of social VR applications.

4.2. Activities performed and psychological outcomes

Our first RQ asked about the relationship between the psychological outcomes of using social VR platforms and the activities performed by the users. We first examined the differences between the reported frequency of the different activities (Fig. 4) by conducting a repeated-measures ANOVA with Greenhouse-Geisser correction, F (4.29, 912.71) = 44.22; $p < .001$, $\eta^2_G = 0.14$, followed by pairwise post-hoc comparisons with the Benjamini-Yekutieli correction (Benjamini & Yekutieli, 2001) (see Annex I). Results show that simply exploring social VR worlds is the dominant activity, followed by activities such as chatting with friends and playing games, or meeting new people. Users engage least frequently in creative activities or attending events.

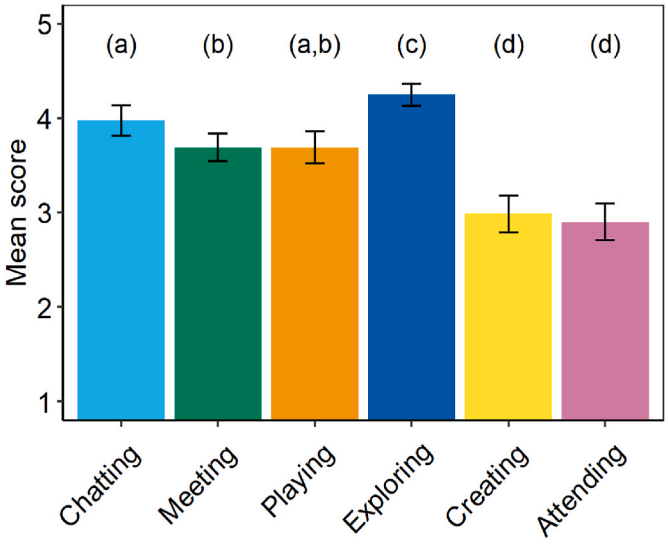

Fig. 4. Mean values of the reported frequency of activities.

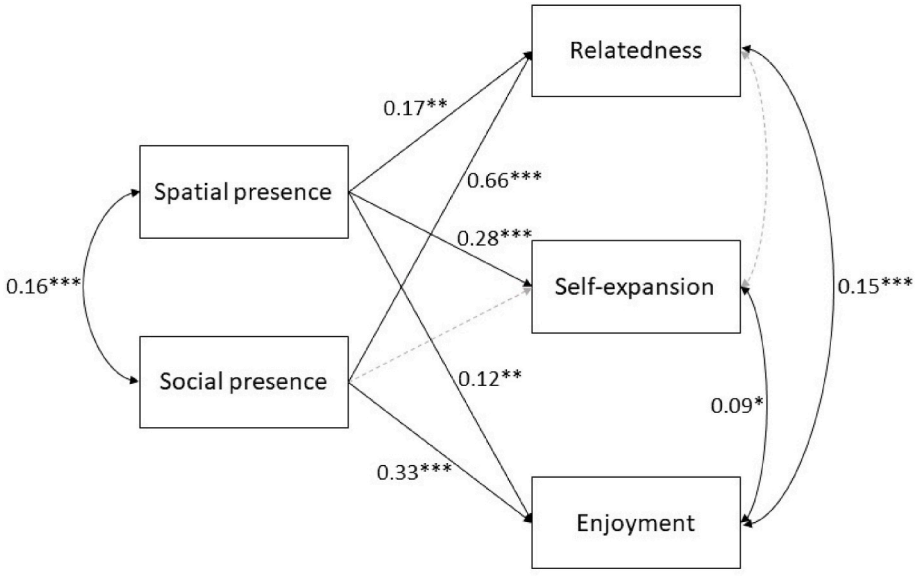

Fig. 3. Model of the associations between spatial and social presence and the three psychological outcomes.

Most of the activity items were correlated with each other, suggesting underlying factors and a more parsimonious dimensional structure. A parallel analysis (Hayton, Allen, & Scarpello, 2004) was then conducted, suggesting a three-factor solution. An exploratory factor analysis with ML estimation and "oblimin" rotation (Table 3) showed that the first factor represented attending events in social VR, the second factor represented social activities (chatting with others and meeting new people), and the third factor represented playful (or, following the terminology by Yee, 2007, immersive) activities (playing games, exploring virtual worlds, creating worlds/avatars).

To address RQ1 and examine the relationships between activities and obtained psychological benefits, a structural equation model (Fig. 5) was fitted. The three activity factors were estimated by each respective activity having a relevant loading on each factor (>0.30; Kline, 2002). All the activity factors were, in turn, modelled as predictors of relatedness, self-expansion, and enjoyment. The model was fitted using the *lavaan* package (Rosseel, 2012), and the indexes of model fitting, χ^2 (16) = 25.00; p = .07; CFI = 0.95; RMSEA = 0.05, 90% CI [0.00, 0.09]; SRMR = 0.05, suggested a good fitting of the model to data (Hu & Bentler, 1999). As Fig. 5 shows, social activity predicted both relatedness and enjoyment, whereas playful use predicted self-expansion. Attending events in social VR platforms did not show significant associations with any of these three outcomes, however.

4.3. Effects of the Covid-19 context

The second research question (RQ2) inquired about how the context of social distancing measures affects the activities performed and the psychological outcomes obtained by users. To tackle this question, we first performed a chi-square test to examine the relationship between users' perception of the impact of the quarantine on their lives and the reported increase in the use of social VR platforms. Both were indeed significantly associated, χ^2 (9) = 40.49; $p<$. 001, in that the reported increase in use of social VR was higher for those saying that the quarantine impacted their daily life more strongly (Fig. 6). This relationship suggests that in the present sample dependence on social VR (as a functional alternative) grew among those that suffered more from the quarantine and social distancing measures.

To explore if the reported impact of the quarantine impacted in which activities users engaged or to what extent users found their social VR experiences rewarding, we regressed both the perceived impact and the reported increase in social VR use on each of the activities, as well as on the factors scores for relatedness, self-expansion, and enjoyment. The results of these regressions yielded no significant effects on any activity or psychological outcome, suggesting that these were neither affected by users' perceived impact of the quarantine, nor their reported increase in use. Hence, whereas those respondents who felt more restricted due to the quarantine apparently used social VR platforms more frequently, they did not experience more rewarding social VR sessions or engaged in different activities in their sessions than users who felt less affected by the quarantine.

Table 3
Results of the exploratory factor analysis for activities.

	F1	F2	F3
Chatting with friends	−0.01	**0.77**	0.00
Meeting new people	0.05	**0.35**	0.10
Playing games	−0.14	−0.10	**0.40**
Exploring virtual worlds	0.02	0.05	**0.63**
Creating new things	0.12	−0.07	**0.36**
Attending events	**1.00**	0.00	0.00
Eigenvalues	1.03	0.72	0.70
Variance explained	0.17	0.12	0.12
Variance explained (cum.)	0.17	0.29	0.41

Notes. **Factor loadings equal to or higher than 0.30 are highlighted in bold.**

5. Discussion

Social VR platforms represent a new option in the menu of media options at the disposal of users to socially interact with others, and to satisfy their needs. Although social VR platforms resemble earlier applications like Second Life in many ways, they also differ due to their immersive capacity provided by VR technology. These platforms represent a new and yet not widespread application type of VR; yet one that users might be particularly prone to adapt to in the present covid-19 crisis and enforced social distancing measures. The present study pursued the goal to examine how the feelings of presence associated with the immersive properties of VR contribute to providing psychological benefits to users, in the context of the covid-19 pandemic.

5.1. Psychological outcomes and presence

Based on a sample of rather heavy users of social VR platforms, our findings suggest that social VR can provide psychological benefits in terms of relatedness, self-expansion, and enjoyment, which are associated with the immersive properties of the medium. These outcomes are interrelated in that both relatedness (Deci & Ryan, 2012) but also self-expansion (Johnson et al., 2016) can foster enjoyment and make social VR fun to use. Using social VR platforms, then, can be best perceived as a leisure time activity that is entertaining, and likely to be driven by users' need to belong or feel socially connected, as well as their need to temporarily get away from the pressures of daily life and to expand their own actual selves. Not surprisingly perhaps, this characterization reminds us that social VR platforms, and the reasons for using them, closely resemble why users turned to related social virtual world applications in the past, like Second Life but also multi-user dungeons (MUDs) or massively multiple online role-playing games (MMORPGs) (Bartle, 1996), or online video games (Li, Liu, Xu, Heikkilä, & Van Der Heijden, 2015; Yee, 2007).

The ability to elicit profound sensations of presence is the most distinctive aspect of social VR platforms compared to other social media, and our findings hint at presence also enhancing the psychological rewards from social VR platforms. Social presence appears as a particularly strong predictor of feelings of relatedness and enjoyment, while spatial presence also predicts self-expansion. Developers of social VR platforms may take into account these aspects to boost their adoption among the population by implementing technical features that maximize both spatial and social presence (Cummings & Bailenson, 2016; Oh et al., 2018), depending on the psychological outcomes targeted.

For example, the present study suggests that above all, it is important that users enjoy using social VR platforms, and enjoyment comes first and foremost from feeling socially related, which again is particularly fostered by social presence. In this context, an important industry trend is the move towards better VR tracking technology, including hand- and face-tracking (e.g., VIVE, Facebook), which will allow enhancing social presence by displaying even more life-like gestures and affective reactions. Another relevant trend is the move towards three-dimensional photorealistic (live) displays of users in VR, e.g., based on volumetric video capturing or computer-generated depictions like Facebook's codec avatars (Richard et al., 2021). While the ability to display and observe natural verbal and embodied communication among seemingly co-present others already fosters high levels of social presence in social VR usage, perceiving a photorealistic rather than cartoonish outer appearance of the other might enhance social presence even further. While this might induce a greater sense of relatedness, and overall fun, notably, this trend might also reduce anonymity, however, and thus limit what users dare to say or do in social VR – thus potentially limiting the social side of self-expansion. Therefore, companies developing social VR applications should carefully consider how the inclusion of new features that enhance social presence (e.g. more identifiable avatars) might, at the same time, negatively impact the satisfaction of some psychological needs (e.g., because of a possible negative effect on

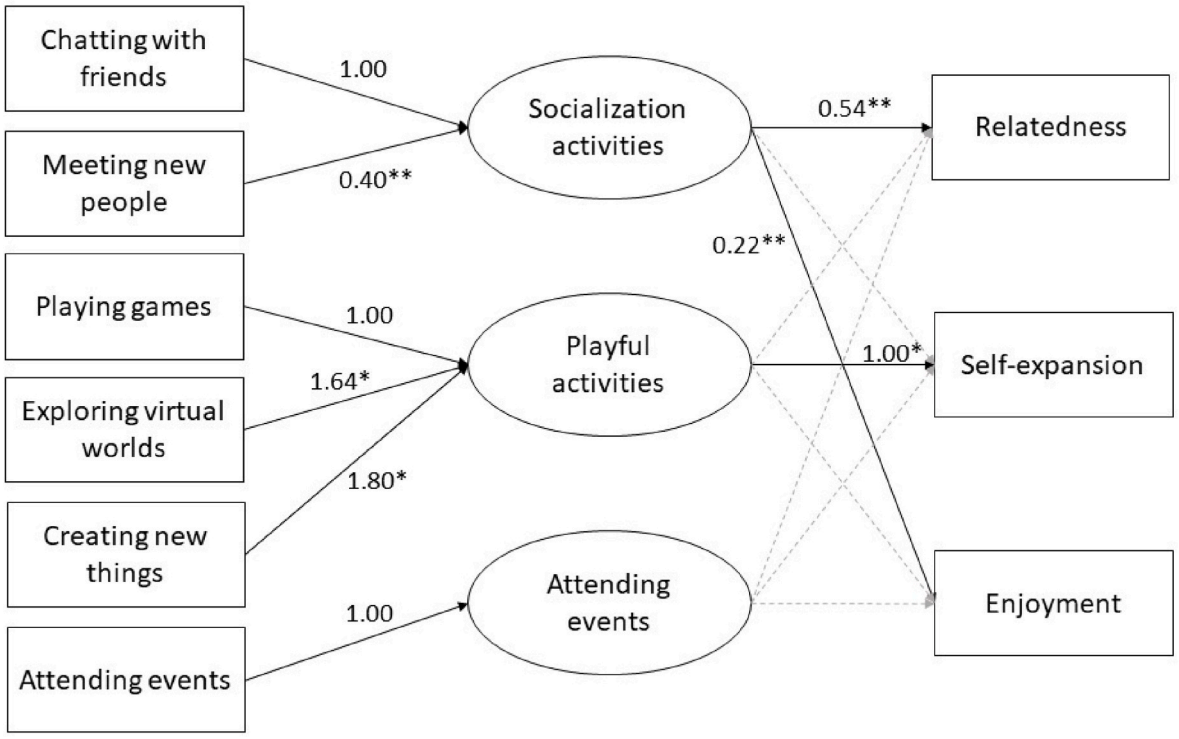

Fig. 5. Graphical representation of links between activities and psychological benefits.

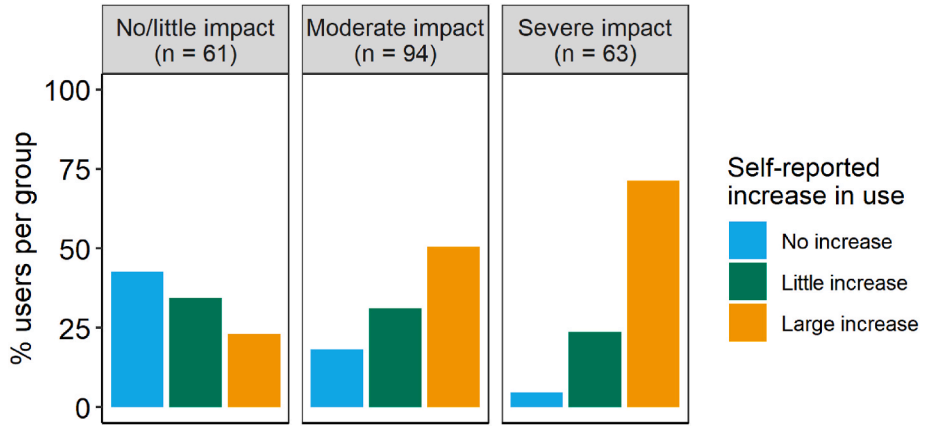

Fig. 6. Increase in use reported per perceived impact of social distancing measures.

reduced anonymity on feelings of self-expansion).

At least in the present study, however, self-expansion hinged more on spatial presence, and on playful (not necessarily social) activities such as the creation of things and exploration of the environment. It seems that future social VR platforms might benefit from further integrating these currently quite distinct activities and psychological benefits, like social relatedness and self-expansion, by socially enriching the latter. One could argue that in present social VR, social and "world"-activities (e.g., exploring) are still two largely distinct activities, perhaps even pursued by distinct users. Relatedly, our own impression is that while present social VR platforms strongly support basic forms of social interaction like chatting, they remarkably differ in the support of other joint social activity (e.g., RecRoom appears to offer more shared games than AltspaceVR), and –in general– seem not yet to have succeeded in substantially and reliably extending social activities beyond chatting with each other. Perhaps this is not only a result of how the apps are designed, but only with greater adoption and stronger representation of user's individual friends on social VR platforms they will embark more routinely on shared social activities.

Results of the present study also revealed that spatial and social presence were correlated with each other, and perhaps they even mutually influenced each other. Indeed, given that physical proximity to others is a factor related to social presence (Oh et al., 2018), feelings of spatial presence may contribute to enhanced social presence. At the same time, since social information is a powerful driver of attention (Klein, Shepherd, & Platt, 2009) and attention to the virtual experience is a precondition for spatial presence (Wirth et al., 2007), feeling the presence of others might also lead to increased spatial presence. Future (experimental) studies seem necessary to further illuminate these causal relationships, but the present findings already suggest that, in the design of rewarding social VR, the interaction between technical aspects, task characteristics (e.g., to what extent they involve social interaction), and the role of spatial and social presence needs to be taken into account.

5.2. Activities and psychological benefits

Our results further suggest that social VR platforms are used to affiliate with others, but can also be rewarding based on perhaps more solitary activities fostering self-expansion, like the creation of an avatar or a virtual room, and the exploration of the virtual environment. Social relatedness, however, is achieved by hanging out with other users that are already friends and by meeting new people. The lacking association with activities such as exploration, playing, or creating things in the present study suggests that social relatedness is mostly achieved in social VR applications by chatting and talking with these others, rather than joint adventures in the virtual environment or co-creative activities or games. If users embark on exploring the environment or playing games -and perhaps these are also different type of users that do so regularly- they seem to rather strive for (enjoyable) self-expansion than fulfilling social needs.

However, we initially also observed overlap between the relatedness and self-expansion gratification, suggesting that self-expansion also features a social component (which we removed to discriminate both gratifications better). Social self-expansion might hint at users not using their actual identity when interacting with others, but relying on a different (and, thus, *expanded*) version of themselves in social VR platforms. For example, previous research has shown that VR users change their behavior depending on the characteristics of their avatars (Gorisse, Christmann, Houzangbe, & Richir, 2019) and that using avatars that are dissimilar to oneself may help reducing anxiety in VR (Aymerich--Franch, Kizilcec, & Bailenson, 2014). Hence, similar to how text-based computer-mediated communication (CMC) might be used (e.g., Bargh, McKenna, & Fitzsimons, 2002; Joinson, 2001), users that feel uncomfortable with their actual self or stigmatized in real life (and who find it hard to socially connect because of that) might be using social VR platforms as a way to overcome these issues. A finding supporting this idea is that, despite the visual richness of the social environment as compared to text-based CMC, users feel save enough in their avatars to self-disclose (Baccon, Chiarovano, & MacDougall, 2019), which is considered central in establishing meaningful social relations.

Another remarkable aspect of the activities performed by users is the emergence of an unexpected factor, solely related to attending to virtual events. It suggests that user might also turn to social VR platforms for instrumental reasons, including serious purposes, such as attending cultural (e.g., exhibitions), professional (e.g., virtual conferences), or even religious events, since all of them are now taking place in this medium. Although the results from Sykownik et al. (2021) suggest that instrumental uses are the minority, these might have a more prominent role in the future, for instance, with the development of social VR applications for educational purposes. Our data showed no relationships between the use of VR for attending events and the three psychological benefits examined. Therefore, the role of presence in relationship with the more instrumental benefits obtained by users remains a matter for future research.

5.3. Impact of social distancing measures

Social media use is largely dependent on contextual factors, and, at the time when this study was conducted, the covid-19 pandemic was by far the most impactful event worldwide. Our results suggest that social VR platforms users have seen in these media a tool to minimize the negative effects of social distancing measures: those reporting a higher impact of social distancing measures on their life also reported a higher increase in the use of social VR applications. However, we also found that greater use does not imply that users also obtain more psychological benefits or engage in more activities on social VR platforms. Future research should consider social VR technology also as a functional alternative to other options available to users, and should explain if reliance on social VR platforms increases under circumstances in which alternative options for need fulfillment become harder to realize, as in the present covid-19 pandemic.

6. Conclusion

Social VR platforms are becoming increasingly popular among users and, compared to previous virtual worlds, they have unique immersive technical properties able to elicit intense feelings of presence. Overall, the findings reported here stress the strong association between such feelings of presence and the psychological rewards that users obtain in terms of relatedness, self-expansion, and enjoyment. This is, to the best of our knowledge, the first study providing a quantitative examination of those associations. Hence, our research points out the important role that immersive VR technology may play in favoring social connectivity and users' wellbeing in scenarios where other options (e.g., face-to-face contact) are not available. This may refer to periods of social distancing, but may also be applicable to other circumstances (e.g., long-distance couples or expat workers). At the same time, our results reveal broad possibilities for social VR platforms to address self-expansion, helping users satisfy those self-related psychological needs that may remain unmet during everyday life. Hence, this study hints at the potential of social virtual reality applications for meeting users' psychological needs, and opens venues for future research addressing a more in-depth analysis of emerging social VR applications.

As with any research, our findings need to be understood within the limitations of the present study. First and most noticeably, the correlational nature of the collected data prevents reaching conclusions regarding causal effects between the variables examined. For instance, a hypothetical causal relationship between psychological benefits and activities may work in both directions: using VR to socialize might lead (e.g., by engaging in more social activities) to achieving more intense feelings of social connectivity, but also having previous gratifying experiences in this respect might enhance the use of this medium for socializing. Whereas our study does not allow us to examine such causal relations, by proving the correlation between the observed variables, our findings motivate a deeper analysis of them in more controlled settings in the future and encourage further research on how social VR platforms may result in beneficial effects for users.

Second, we did not collect any direct measure of participants' psychological needs, which would have been helpful to more clearly illuminate the role of social VR platforms in satisfying them. This was motivated by the aim to keep the survey as short as possible to maximize participation. Future studies on the topic should consider measuring not only the psychological benefits obtained but also the levels of the diverse psychological needs that drive the use of social VR platforms.

Third, and relatedly, an exhaustive examination of the motivational aspects of the use of social VR platforms may require considering also other possibilities neglected here. Our results stress the significant association between feelings of presence and three psychological benefits that users derive from exposure to this medium, but the relationship between presence and other types of use (e.g., a more instrumental use, perhaps related to attending events) also deserve to be further explored. Neither did we gather data on feelings of embodiment (or self-presence; Skarbez, Brooks, & Whitton, 2017), another dimension of presence that, together with spatial and social presence, might explain why people use these new applications. Furthermore, we relied only on self-report data, and did not account for habitual use of social VR platforms. While we believe that our application of self-report methods is valid, in an early stage of the adoption of social VR platforms in which user habits are also still unlikely to be fully developed or determining exposure, future studies on the topic might want to probe the effect of already established habits to use social VR platforms as well (e.g., LaRose, 2017).

Finally, the size of the present sample might be considered relatively small, which can raise generalizability issues. We believe that, since our hypotheses describe associations between feelings of presence and psychological outcomes, the same relationships should hold across users with different individual characteristics, and across platforms with

different technical features, as long as users experience similar feelings of presence. However, further research with larger samples is needed to ensure the generalizability of our results. Moreover, our convenience sample includes participants with a large age range, from a variety of countries, and using different platforms. Whereas we focused on feelings of presence (and their association with psychological outcomes), we did not examine how specific individual factors or specific technical aspects of different platforms may influence such feelings. Since the adoption of VR technology in society is dynamically evolving it is certainly important to re-examine our findings among a potentially larger and more diverse user base in the future, and to distinguish different technical features, and related communicational affordances (e.g., varying levels of anonymity) of social VR platforms in this context.

CRediT author statement

Miguel Barreda-Ángeles: Conceptualization, Data curation, Formal analysis, Funding acquisition, Methodology, Writing - original draft; Writing - review & editing. Tilo Hartmann: Conceptualization, Formal analysis, Funding acquisition, Methodology, Writing - review & editing.

Declaration of competing interest

None.

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Annex I. Results of the post-hoc pairwise comparisons on the frequency of activities, with Benjamini-Yekutieli correction

Comparison	*t*	df	*p* (adjusted)	significance	*D*
Chatting vs. Meeting	3.05	213	0.01	*	0.25
Chatting vs. Playing	2.23	213	0.10		0.22
Chatting vs. Exploring	−3.12	213	0.01	**	0.28
Chatting vs. Creating	7.57	213	<.001	***	0.73
Chatting vs. Attending	8.14	213	<.001	***	0.79
Meeting vs. Playing	−0.17	213	1		0.02
Meeting vs. Exploring	−6.67	213	<.001	***	0.59
Meeting vs. Creating	5.56	213	<.001	***	0.53
Meeting vs. Attending	6.46	213	<.001	***	0.60
Playing vs. Exploring	−5.96	213	<.001	***	0.51
Playing vs. Creating	5.67	213	<.001	***	0.51
Playing vs. Attending	5.90	213	<.001	***	0.58
Exploring vs. Creating	12.40	213	<.001	***	1.04
Exploring vs. Attending	12.97	213	<.001	***	1.11
Creating vs. Attending	0.67	213	1		0.06

*$p < .05$; **$p < .01$; ***$p < .001$.

Notes. Abbreviations for the activities: Chatting: "Chatting with friends"; Meeting: "Meeting new people"; Playing: "Playing games"; Exploring: "Exploring virtual worlds"; Creating: "Creating new things (new worlds, avatars, etc.); and Attending: "Attending virtual events (concerts, exhibitions, etc.)."

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