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Interacting in Virtual Reality : When the Proteus effect stimulates 3d MMORPG players to buy.

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Abstract:

Virtual reality is transforming people's behaviour in new online multiplayer games. However, the question of how this technology influences players' virtual object purchasing behaviour remains open. To answer this question, this research mobilises the theory of embodiment, the theory of community commitment and the sense of social belonging to explain the behaviour of the embodied gamer. Using a sample of 567 players of massively multiplayer online role-playing games in virtual reality, our study establishes conclusive evidence that player embodiment influences player purchase behaviour. Furthermore, our results reveal the presence of a mediating effect between embodiment and the purchase of virtual objects. In other words, players buy virtual objects because embodiment reinforces their commitment and their sense of belonging to their community. Clearly, this research is the first to propose this model in the field of online multiplayer games. Professionals should exploit these groundbreaking results and democratise virtual reality in games. In addition, it is important that the virtual interfaces deployed in games are more engaging, personalised and community-based.

Keywords:

virtual items, embodiment, Proteus effect, deindividuation, community commitment, social belonging, projective identification, purchase intention

1. Introduction

While virtual reality (VR) is developing in massively multiplayer online role-playing games (MMORPGs) (Goh *et al.*, 2023), the literature does not explore its influence on player purchasing behaviour. Yet these games attract millions of players and generate more than US\$12 billion a year (Badrinarayanan *et al.*, 2015). Gamer communities are growing rapidly (Shukla & Drennan, 2018). Currently, World of Warcraft has nearly 7 million active players. MMORPGs are cyberspaces where players embody an avatar and evolve in communities (Sourmelis *et al.*, 2017). To progress, players need to work together as a team (Castronova *et al.*, 2008). In addition, to rapidly develop their avatar's skills, players purchase virtual objects (VIs) (Guo & Barnes, 2011). VIs are important virtual resources for both the player (Kim *et al.*, 2011) and the publisher. Through VIs, players express their virtual identity (Shelton, 2010) and publishers secure a sustainable source of revenue (Garnier & Prosatk, 2015). It is therefore important to gain a deeper understanding of the mechanisms that influence players' purchasing behaviour in MMORPGs.

Most of the work analyses this behaviour in a traditional 3D environment (computer screen display). This work focuses in particular on motivational variables,

perceived value and pleasure (for example: Yee, 2007; Shelton, 2010; Park & Lee, 2011; Ho & Wu, 2012; Mäntymäki *et al.*, 2014; Dindar, 2018; Shukla & Drennan, 2018). Finally, little is known about the influence of VR in MMORPGs. Moreover, while VR is of interest to researchers (Dincelli & Yayla, 2022), there is still a lack of research into people's behaviour (Loureiro *et al.*, 2020), including in video games (Goh *et al.*, 2023). Yet VR offers an alternative to traditional interactions between individuals (Chang & Lee, 2022). This technology changes the nature of social relationships between players (Goh *et al.*, 2023). In VR, the individual navigates realistically (Cummings & Bailenson, 2016; Zhou *et al.*, 2023). This realism is promoted by virtual embodiment (Flavián *et al.*, 2019; Herz & Rauschnabel, 2019).

Virtual embodiment corresponds to the projection of the individual's body into a virtual envelope (Lenggenhager *et al.*, 2007). In VR, individuals embody an avatar and interact as they do in the real world (Flavián *et al.*, 2020). The avatar becomes a virtual extension of the human body. Embodiment leads to new social and emotional experiences (Flavián *et al.*, 2020; Huang *et al.*, 2023). It transforms perceptions and engages individuals more fully in this virtuality (Tussyadiah *et al.*, 2017). Through engagement, individuals become involved for a long time, emotionally and actively (O'Brien *et al.*, 2018) for the benefit of their community. Many studies demonstrate

the positive impact of virtual embodiment on individual engagement (Bec *et al.*, 2019; Willems *et al.*, 2019; Flavián *et al.*, 2020; Meißner *et al.*, 2020). However, to our knowledge, no study analyses the influence of virtual embodiment on player behaviour in the field of VR MMORPGs. Therefore, based on the previous discussion and the objectives of the study, the following research questions are proposed:

RQ1. In the context of VR MMORPGs, does virtual embodiment influence players' community commitment and sense of social belonging to their community?

RQ2. In the same context, is the player's purchasing behaviour influenced by community commitment and a sense of social belonging to the community?

To answer these questions, the study draws on the foundations of embodiment theory (Longo *et al.*, 2008; Kilteni *et al.*, 2012). According to Klein (1946), embodiment promotes the projection of the self (attitudes and behaviours) into another body. In this way, embodied players are immersed in their community (Garnier & Poncin, 2013) and become actively involved in it. Over time, this engagement increases the player's sense of social belonging and encourages their intention to purchase VI. To test our model and our hypotheses, we carried out a structural equation analysis. To do this, we collected a total sample of 567 players of a recent VR MMORPG.

Our work contributes to research and practice in several important ways. From a theoretical point of view, this research is in line with several academic recommendations. These are to better understand the influence of VR on individual behaviour (Herz & Rauchnabel, 2019) and to study the influence of virtual embodiment on gamers' purchase behaviour (Ratan *et al.*, 2020). As such, our research demonstrates the influence of VR on individual behaviour in VR MMORPGs. In particular, our results demonstrate the combined effect of virtual embodiment, belonging and engagement on player purchase behaviour. This is the main originality of this article. Our results also highlight the mediating effect of social belonging and community involvement on players' purchase intention.

From a managerial point of view, this study invites professionals to become aware of the importance of VR in these community games. The embodiment generated by VR encourages players to become more involved and to purchase VIs to personalise their avatars. We advise video game industry professionals to democratise the use of this technology. Basically, we provide exclusive, usable information to help publishers improve their games by proposing innovative solutions to increase their revenues in the long term.

In the following section, we review the literature in order to position our research in the overall theoretical context. After explaining the framework of player purchasing behaviour in MMORPGs and presenting the challenges of VR, we describe our research model and methodology. We then present the results of our empirical study and discuss them in relation to the existing literature. Finally, we discuss the main

theoretical contributions, managerial implications, limitations and future research prospects.

2. Theoretical background

2.1. Theoretical foundations of VI purchasing behaviour in MMORPGs

In MMORPGs, the individual enters the game via an avatar. The avatar is a fixed or animated virtual character that virtually represents the player (Garnier & Poncin, 2013). This digital twin offers individuals numerous possibilities for exploring their identity (Shelton, 2010). This exploration is made possible by the personalisation of the avatar, and facilitated by the large pool of VIs available to the player. Purchases of VI are very common in MMORPGs. This new digital economy is attracting a great deal of attention from the public authorities, who are trying to regulate it more effectively (Castronova *et al.*, 2008; Papagiannidis *et al.*, 2008). Oh and Ryu (2007) and Lin and Sun (2007) state that the virtual objects associated with avatars are of two kinds. They can be functional to develop the character's skills and performance (weapons, artefacts, etc.). They can also be aesthetic to decorate and/or modify the character's appearance (clothes, animals, etc.). The literature on player purchasing behaviour highlights a number of taxonomies.

In his empirical work on sources of motivation, Yee (2007) developed a classification based on three fundamental components, namely achievement (advancement and competition), social (socialisation and relationship) and immersion (personalisation and escape). In the same vein, the work of Shelton (2010) added identity motivation (expression of the virtual self) to encourage the acquisition of VIs. Hassouneh and Brengman (2014) also found that purchase motivations can be linked to players' profiles with regard to the game.

In a complementary logic, some authors have highlighted the importance of pleasure and hedonism in VI purchase intention (Kim & Ross 2006; Guo & Barnes, 2011). This hedonism is reinforced by the proposition of immersive environments centred on the user. This encourages the emergence of positive attitudes towards gaming (Jung *et al.*, 2014) and generates pleasure in the player (Lee *et al.*, 2020). The aim is to position the player in a high state of flow to encourage them to play sustainably (Csikszentmihalyi, 1990; Kim *et al.*, 2011; Tan & Yang, 2022). However, this approach has been challenged by Hamari (2015) who found a negative path between enjoyment and purchase intention. Hamari (2015) suggests, however, that willingness to purchase is significantly correlated with gamers' attitudes towards VIs and their peers' beliefs and opinions (Huang, 2016).

In a different theoretical framework, other authors have been interested in analysing purchase behaviour through the perceived value of VIs (Kim *et al.*, 2011). Like real products sold, VIs have functional, hedonic and social attributes (Kim *et al.*, 2011) to which the player associates specific consumption preferences, values and purchase motivations (Zhaohui, 2012). For example, achievement and discovery motivations influence the object's attributes and functional values. Conversely, identity expression motivations influence social attributes and values (Zhaohui, 2012). When players perceive high value in VIs, they are more inclined to purchase them (Park &

Lee, 2011). Finally, purchase intention may also depend on the perceived usefulness of VIs and the time savings offered in the rapid growth of avatar skills and community performance (Dindar, 2018; Guo & Barnes, 2011).

Table 1: The VIs purchase process in MMORPGs, analysed through the different theoretical prisms used.

Study	Research objectives	Theories mobilised	Dependent variable	Main results
Jin et al. (2017)	- To assess the impact of technological variables (interactivity and sociability) on social presence and the impact of social variables (social ties and social identity) on player engagement. - To analyse the influence of social presence and user engagement on the purchasing behaviour of players.	Social presence theory User engagement theory	Intention to buy	- Interactivity and sociability variable social presence and social ties and identity variables affect player engagement. - Social presence and user engagement positively influence player purchase intention.
Badrinarayanan et al. (2014)	- To assess the impact of the variables of presence, challenge and involvement on tribalism and player engagement in the community. - To analyse the influence of tribalism on purchase intention, WOM and recruitment of new players.	Segmental lineage theory Dual process theory Experiential consumption theory	Intention to buy	- The variables of presence, challenge involvement positively influence tribalism player engagement in the community. - Tribalism significantly influences purchase intention, WOM and recruitment of players.
Shelton (2010)	- To assess the impact of user motivations (identity, social and achievement) on virtual shopping behaviour in second life. - To analyse the impact of motivations from the virtual world on real-world purchasing behaviour.	Gaming motivations theory Uses and gratification theory	Intention to buy	- Identity, entertainment and achievement motivations positively influence player purchase intention. - Motivations from the virtual world positively influence the purchase of objects in the real world.
Wu & Hsu (2018)	- To identify the influence of factors of aesthetic design, avatar identification and co-creation behaviour on players' perception of authenticity. - To analyse the real impact of authenticity on the MMORPG player's intention to play and purchase.	Authenticity theory of play	Intention to play Intention to buy	- The variables of aesthetic design, identification and co-creation behaviour positively affect the perception of authenticity among players. - Authenticity in the game positively influences players' purchase intention.
Shukla & Deshpande (2018)	- To evaluate the influence of individual and group variables on virtual item purchasing behaviour in MMORPGs. - To identify the mediating effect of group variables on player purchase intentions.	Social network theory Social influence theory Motivational gain theory	Intention to buy	- Individual and group variables positively influence players' purchase intention. - The group variables have a significant mediating effect on the players' purchase intention.
Li & Shi (2014)	- To assess the influence of customer preference characteristics on the quality of the collaborative game filtering system. - To identify the influence of the collaborative game filtering system on customer satisfaction with the OV recommendation system.	Hierarchical analytical process Preference similarity coefficient	Satisfaction Intention to buy	- The analysis of customer preference characteristics positively influences the performance of the collaborative filtering system. - The performance of the game's collaborative filtering system significantly affects customer satisfaction with the game's OV recommendations.
Lu et al. (2019)	- To analyse the influence of social interactions on the communication behaviour between players in same guild. - To assess the impact of communication behaviours between players on their purchase intentions.	Model: Communication Weighted Behavioral Sophistication	Intention to buy	- Social interactions positively influence the communication behaviour between players in the same guild. - Communication behaviours between players positively influence the purchasing behaviour of players.
Hota & Dierball (2016)	- To analyse the influence of gender (girl/boy) on children's motivation to play. - To assess the impact of play motivations on children's purchase intention.	Gaming motivations theory	Intention to buy	- Children's gender (girl/boy) differently affects their motivation to play. - Boys buy OV for the pursuit of progress and power and girls buy OV for the enhancement of social status.
Kim & Kim (2019)	- To assess the impact of user characteristics (level, frequency of purchase and duration of play) on the perception of promotional events. - To analyse the influence of promotional events on player churn and in-game purchase intentions.	User attrition rate	Intention to buy	- The perception of events varies according to user characteristics (level, frequency of purchase and duration of play). - Promotional events significantly reduce player churn in the MMORPG and positively influence purchase intentions.
Ali & Yoo (2017)	- To analyse the impact of players' cheating behaviour on the willingness to digitally hack the game. - To assess the influence of the use of digital piracy tools on the playing time (interest in the game) and players' purchasing behaviour. - To analyse the impact of social exchanges on players' identification with the community and the game.	Online cheating behaviour Digital piracy	Playing time (interest) Intention to buy	- The cheating behaviour of players positively affects their willingness to digitally hack the game. - The use of digital hacking tools positively influences players' playing time (interest in the game) and their purchasing behaviour in the game. - The nature of social exchanges positively affects players' identification with the community and the game.
Wang & Liu (2015)	- To assess the influence of community and game identification on player purchase intention.	Organisational justice theory Social exchange theory Identification theory	Intention to buy	- The players' identification with the community and the game positively influences purchase intention.
Ahmed et al. (2011)	- To identify the impact of telepresence and social presence on the flow in the game. - To evaluate the influence of telepresence and social presence on the flow on the player's buying behaviour.	Flow theory Theory of presence	Intention to buy	- Telepresence and social presence positively affect the flow in the game. - The flow positively influences the player's purchase intention. - Telepresence and social presence do not have a significant impact on player purchasing behaviour.
Mäntymäki & Salo (2013)	- To identify the impact of the variables of the UTAU model (perceived enjoyment, perceived usefulness, self-efficacy, facilitating condition) on the purchasing behaviour of players. - To assess the influence of social presence and network size variables on the purchasing behaviour of players.	Network theory Social presence theory Hedonic information systems theory Technology acceptance model Self-efficacy theory	Intention to buy	- The variables in the UTAU model positively influence the player's purchase intention except for the self-efficacy variable. - The size of the network has a positive influence on the purchase intention of the players. - Social presence has no influence on purchase intention.
Mäntymäki et al. (2014)	- To identify the impact of experience (perceived enjoyment, perceived control, curiosity, immersion and temporal disassociation) on players' purchasing behaviour. - To assess the influence of the variables of social presence, perceived network size and network trust on players' purchasing behaviour.	Social presence theory Hedonic information systems theory Technology acceptance model Flow theory	Intention to buy	- The experience (perceived pleasure, perceived control, curiosity, immersion and temporal disassociation) positively influences players' purchase intention. - Trust and the perceived size of the network positively influence players' purchase intention. - Social presence has no influence on purchase intention.

(Animesh et al., 2011; Mäntymäki & Salo, 2013; Mäntymäki et al., 2014). In reality, the sense of presence can only be apprehended through virtual embodiment in VR (Biocca, 1997; Grabarczyk & Pokropski, 2016). These links are addressed in the literature through sport (Kim & Ko, 2019), tourism (Leveau & Camus, 2023) or e-commerce (Alzayat & Lee, 2021). The global VR market is growing (Loureiro et al., 2020), and it is expected to reach US\$20.9 billion by 2025 (Dincelli & Yayla, 2022). MMORPGs are benefiting from rapid technological developments (Goh et al., 2023) with the emergence of VR. These developments are overturning the standard mechanisms for using these games (Chang & Lee, 2022).

2.2. The world of MMORPGs and virtual reality technology.

These computer-mediated play worlds are determined by physicality, persistence and constructed space (Castronova et al., 2008). Physicality defines a virtual world where ecological laws are respected. Players move around in a manner similar to the natural environment. Persistence evokes a digital world that is constantly evolving, even when the player is not playing. Finally, constructed space is the characteristic of a world with specific rules, constituting a distinct game space. In this way, players can easily simulate all kinds of experiences that are difficult to access in reality (Castronova et al., 2008). MMORPGs are community-based universes offering players the opportunity to play within powerful and evolving gaming communities. These games create authentic virtual societies teeming with interconnected individuals (Lehdonvirta, 2005). Unlike traditional 2D or 3D MMORPGs (3PP view), VR MMORPGs involve players to a greater extent (Chen & Lin, 2022) with an embodied vision. The realism and fluidity offered by VR increase the state of flow (Chen & Lin, 2022), stimulate positive emotions (Flavián et al., 2020) and the imagination and creativity of players (Kim & Choi, 2023; Zhou et al., 2023).

Originally, the work of Milgram and Kishino (1994) defined a continuum of virtuality. In this continuum, VR environments are opposed to the real world because the properties of the physical world no longer apply. Numerous taxonomies have been formulated to define the different technological degrees of virtuality. Mills & Noyes (1999) used the immersive or non-immersive nature of the technology and Mann (2002) used the degree of technological mediation. Recently, faced with the diversification of new virtual technologies, Rauschnabel et al. (2022) have developed the extended reality (XR) continuum. Figure 1 gives an overview of the different technologies in relation to existing taxonomies.

Most of the articles presented in Table 1 come from the Web of Science platform. Moreover, most of them are among the most cited articles in the field of MMORPG players' purchasing behaviour. This table highlights some important points in the existing literature. It sheds light on existing gaps in the analysis of VR MMORPGs. All the work listed concerns online games where the player observes their avatar (third-person view - 3PP) but does not embody it (first-person view - 1PP). This finding offers a new perspective to explain differently the purchasing behaviour of gamers through virtual embodiment. In addition, the table reveals significant conclusions about the importance of VR in MMORPGs. Some research does not show the significant influence of presence on purchase intention of VIs

Fig. 1 - Overview of virtual technologies analysed using the various taxonomies in the literature.

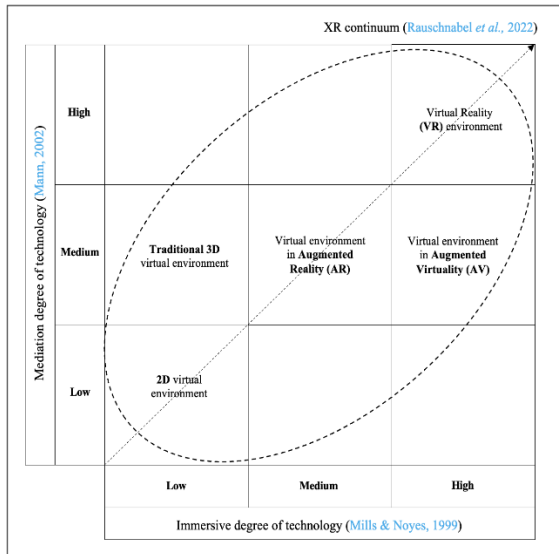


Figure 1 classifies technologies according to their degree of mediatisation and immersion. Mediatisation refers to the technology's ability to transform real environments into virtual universes (Mann, 2002). Consequently, the greater the mediatisation, the more immersive the technology. In other words, the more people are surrounded by virtuality, the more they immerse themselves in it. Included in the extended reality continuum (Rauschnabel et al., 2022), VR is an advanced digital 3D technology. Thanks to its embodiment mechanism (Flavián et al., 2019), VR offers high levels of technological immersion generated by full mediatisation of the technology. Embodiment is enhanced by the many technological artefacts deployed by VR, such as stereoscopic vision, tracking level and image quality (Cummings & Bailenson, 2016). Embodiment leads to a high level of technological integration allowing a fusion of the individual and the technology (Tussyadiah et al., 2017). Incidentally, embodiment is an important dimension in the analysis of human-computer interactions (Dix, 2017) in VR worlds.

2.3. The theory of embodiment

The embodiment of the self relates to the principle that consciousness is located in the physical body (Lenggenhager et al., 2007). The sensation of feeling one's own body is linked to the sense of self and constitutes the starting point for individual identity (Longo et al., 2008). However, Botvinick and Cohen (1998) highlighted the brain's ability to project itself into an external body. By using the three senses (visual, haptic and proprioceptive) in a synchronised manner, they succeeded in deceiving individuals into believing that a dummy rubber hand was their own. Thus, embodiment is experienced when individuals, thanks to implemented stimuli, project themselves into another body with the sensation of controlling it (Debarba et al., 2017).

According to Kilteni et al. (2012), the sense of embodiment can be defined as: "The sense of embodiment with respect to a body B is the sense that emerges when the properties of B are treated as if they were the properties of

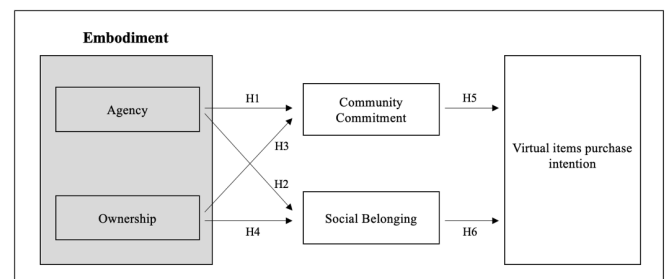
one's own biological body". Embodiment is often associated with the feeling of presence in virtual environments, defined as the feeling of "being there" (Heeter, 1992) and of evolving in the virtual environment as if it were real (Slater & Wilbur, 1997; Erickson-Davis et al., 2021). Embodiment is a psychological lever mediating between immersion and the feeling of presence (Grabarczyk & Pokropski, 2016). In other words, between the moment when the individual feels enveloped in the virtual universe (Slater et al., 2009; Nilsson et al., 2016) and the ecstatic state of feeling like an actor in this cyberspace. The feeling of embodiment is characterised by the following three components: agency (I am responsible for movements), ownership (I attribute the virtual body to my own body) and location (I situate my real self in the virtual body and space) (Roth & Latoschik, 2020). The feeling of ownership and the sense of action are part of a pre-reflexive experience of embodied experience (Tsakiris et al., 2007). There is no sense of action without a sense of ownership, and vice versa. Many studies have focused on analysing embodiment through the two components of agency and ownership (Banakou & Slater, 2014; Argelaguet et al., 2016; Jeunet et al., 2018).

In summary, our study provides an innovative and as yet underappreciated look at understanding the impacts generated by VR on player purchase behaviour in MMORPGs. By becoming the protagonist of the destiny of their "virtual ego", players develop a strong sense of belonging and commitment to their community (Proteus Effect - Yee & Bailenson, 2007), with the ultimate effect of purchasing VIs.

3. Research model

The aim of this study is to apply the foundations of embodiment theory to the analysis of the purchasing behaviour of VR MMORPG players (Figure 2). We also mobilise the constructs of community involvement and sense of social belonging as mediating variables for embodiment and intention to purchase VI. We believe that the purchase of VI is influenced by virtual embodiment but that this purchase intention is reinforced by community involvement and the feeling of social belonging.

Fig. 2 – Conceptual model



3.1 Embodiment, community commitment and social belonging

Agency significantly influences ownership and the individual's sense of embodiment in the virtual body (Jeunet et al., 2018). When congruence between movements and sensory perceptions is strong, ownership

and agency develop (Jeannerod, 2003). The impact of embodiment on community engagement and social belonging can essentially be assessed through agency and ownership. Localisation is, in a way, a consequence of these. Moreover, Longo et al. (2008) suggest that these three components form a coherent whole that can be dissociated in a specific analysis of embodiment. Consequently, our model assesses embodiment through agency and ownership. Agency refers to the individual's sense of authorship (Slater et al., 2010). It is characterised by intention, motor selection, action and final control of movement (Kilteni et al., 2012).

In virtual universes, agency occurs when the avatar's movements are modelled on the player's own actions (Pugliese & Vesper, 2022). The user transfers agency to the avatar and acts virtually through it. The greater the sense of agency, the greater the individual's sense of presence in the virtual game. Slowinski et al. (2016) state that the similarity between the individual's movements and those of their avatar promotes coordination with their team members. Jeunet et al. (2018) have shown that a high sense of agency increases the feeling of presence in the digital world. Ayed and Dorta (2021) assert that a high sense of agency improves a group's team spirit and creativity. The interactivity offered by virtual embodiment encourages the player to engage with the virtual world (McCreery et al., 2015; Flavián et al., 2020). The engagement of the individual is an essential dimension in the VR experience (Wei, 2019), through virtual embodiment.

Therefore, we argue that agentivity promotes player community engagement in VR MMORPGs. Thus, we formulate the following hypothesis:

H1: Agency positively influences a player's community commitment.

In their work on social capital, Kim et al. (2012) suggest that an individual who identifies with their avatar has an increased sense of trust and social belonging to the group. Ren et al. (2012) came to the same conclusions in the context of online communities. When individuals identify with the community, attachment and belonging to the group is reinforced. The work of Pugliese and Vesper (2022) on the theory of digital joint action reveals a positively significant link between agency and the team's sense of coordination. This link strengthens the sense of belonging to the virtual community. In addition, individuals attach more importance to the links and components associated with virtual situations when they perceive them as real (Heidegger et al., 2010). Through agentivity, embodiment facilitates the projection of the individual into their avatar and increases their engagement (Tussyadiah et al., 2017; Flavián et al., 2020). Haines (2014) argues that when individuals engage with the virtual team on a sustained basis, a sense of trust, reciprocity and belonging develops between members.

In MMORPGs, the community plays an important role in social interactions and the construction of the social capital of belonging (Perry et al., 2018). The community forms an ensemble that frames the player's gaming experience by diffusing a stable and lasting social

setting (Ducheneaut et al., 2007). According to Hsu and Chang (2022), the quality of interactions between players influences the social capital to which they belong. The more fluid and realistic the interactions, the stronger the bonds between players.

We therefore argue that agency improves the quality of virtual interactions in the VR MMORPG, promotes the identification of the individual with their avatar and community and reinforces social belonging. Thus, we also put forward the following hypothesis:

H2: The agency has a positive influence on a player's social belonging.

For embodiment to be complete, the individual must be the primary subject of the virtual persona. Kilteni et al. (2012) argue that ownership is the attribution of a virtual self as one's own body. Slater et al. (2009) suggest that the correlation of visual, haptic and proprioceptive factors explains virtual body ownership. The feeling of ownership and the sense of action are an integral part of the embodied experience. It is broken down into efferent signals (visual and proprioceptive/kinesthetic information) and afferent signals (motor control) (Tsakiris et al., 2007). The more congruent the afferent and efferent signals, the greater the sense of ownership (Tsakiris et al., 2007).

In MMORPGs, the avatar is defined as a virtual character driven by human behaviour (Kilteni et al., 2012). A strong sense of ownership of the avatar accentuates the feeling of being present in the community as a salient virtual individuality. The individual will be able to exert influence within the group, satisfy individual needs and share common interests (Wu et al., 2010). By having the feeling of owning their avatar, players immerse themselves and become involved in the community.

We therefore argue that an individual's sense of ownership of their avatar strengthens the player's commitment to their virtual community in VR MMORPGs. We therefore propose the following hypothesis:

H3 : Ownership has a positive influence on a player's community commitment.

Over time, the avatar becomes stronger and the "avatar-self" bond becomes stronger (Nagy & Koles, 2014). The more the player feels they own the avatar, the more attached they become to it (Watkins & Molesworth, 2012). Through this attachment, the individual develops a strong virtual identity projection within their community (Nagy & Koles, 2014) and occupies an important place in their online community. In line with the Proteus effect, Yee et al. (2009) suggest that positive identification with one's avatar implies a modification of the player's attitudes and behaviour in favour of the group. Kim C. et al. (2012) proved that a dual identification with (1) one's avatar, through its strong attractiveness, and (2) one's community, through strong social support, leads to the emergence of a feeling of trust, inducing a sense of social belonging (Park & Chung, 2011). Wilde & Evans (2017) have demonstrated the influence of an emphatic bond between the player and their avatar on their community. This bond strengthens the affective relationship between

the player and their avatar and positively affects their social belonging to the community.

Therefore, we argue that a strong sense of ownership towards one's avatar implies a close relationship between the player and clan and promotes the emergence of a strong sense of social belonging in VR MMORPGs. On this basis, we propose the following hypothesis:

H4: Ownership has a positive influence on a player's social belonging.

The Proteus effect is accentuated by the sense of embodiment. In fact, the embodiment offered by these immersive 3D environments is an excellent lever for the emergence and development of a powerful Proteus effect (Yee & Bailenson, 2009). By identifying with the virtual character, the real identity fades away in favour of the virtual identity of the avatar, associated with the role played in the community of players. In this way, the Proteus effect accentuates community involvement, social belonging and, through a mediation effect, the player's intention to purchase VIs.

3.2 Proteus effect, community commitment, social belonging and purchase intention

In MMORPGs, the virtual community is a genuine platform through which members interact to progress, develop friendships and share common interests. The avatar becomes the player's main source of identity, through which they express their attitudes and community behaviour. The expression of these attitudes and behaviour in relation to the avatar's identity corresponds to the theory of the Proteus effect (Yee & Bailenson, 2007). The appearance of the avatar (size, sex, type, accessories, etc.) profoundly modifies the identity projection of the player in the virtual world (Peña et al., 2009; Fox et al., 2013; Stravopoulos et al., 2021). Ratan et al. (2020) claimed that the Proteus effect is strong when players simultaneously associate models linked to the self and the avatar. With embodiment, identification with the avatar reinforces the player's immersion in the game (Stravopoulos et al., 2021).

Some research has revealed the beneficial effects of an individual's identification with their avatar on their engagement and VI purchase intentions (Kim, H.W. et al., 2012; Badrinarayanan et al., 2015). Kim, H.W. et al. (2012) argue that strong identification with the community generates a favourable attitude towards exploiting virtual worlds and purchasing VI. Wu and Hsu (2018) argue that when players project themselves in their avatar, they contribute to the development of their community and purchase VI. In addition, the role occupied by the player in the community encourages them to purchase VI (Rolland & Parmentier, 2009) to improve their skills and create more social links (Tonteri et al., 2011). Belaud et al. (2017) came to the same conclusions in their study of online community games. This desire to perform, linked to the spirit of competition and the role occupied by the player, puts them in a state of perseveration. This perseveration leads them to buy VIs to maintain their level in the game.

We therefore argue that the Proteus effect leads individuals to project themselves fully into their community through their avatars. This community identity leads VR MMORPG players to become actively involved in the success of their community and to buy VIs. We therefore suggest the following hypothesis:

H5: Community commitment has a positive influence on a player's purchase intentions.

Social belonging is directly linked to the relationship between the individual and his or her community. It can be defined as all the relationships and the strength of the relationships that an individual develops with other members (Petter et al., 2020). Social belonging is linked to attachment social capital, rooted between individuals with close and emotional relationships (Ellison et al., 2007). Moreover, a community is built around social relationships that stimulate belonging, satisfaction and membership between members (Chavis and Newbrough, 1986). Virtual communities are places where information sharing, friendship seeking and social support are omnipresent (Ridings & Gefen, 2004).

In MMORPGs, social belonging leads individuals to join virtual communities with norms, values and stereotypes that modify their behaviour (Peña & Blackburn, 2013; Petter et al., 2020). Cleghorn and Griffiths (2015) suggest that the purchase of VIs equips the avatar according to the group's norms and reinforces social belonging to the community. The work of Lo (2008) shows that these games involve virtual communities in which players buy VI to reinforce an identity normalised by the group. In other words, players buy VI to increase their attractiveness and be better accepted by others. Moreover, the search for acceptance by the community is an important lever in the player's purchase intention (Hassouneh & Brengman, 2014). In a similar approach, Yahia and Chaabouni (2015) argue that strong social belonging increases the purchase intentions of group members to actively participate in the community. Social belonging is linked to the Proteus effect and more specifically to the deindividuation mechanism it generates. Lea et al. (2001) state that anonymity increases an individual's attraction to the group. In this way, the individual self-stereotypes through the purchase of VI in order to align himself closely with the group.

Therefore, we argue that social belonging drives the player's desire to identify with community norms through the purchase of VIs in VR MMORPGs. Thus, we put forward the following hypothesis:

H6: Social belonging has a positive influence on a player's intention to buy.

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4. Methodology

4.1. Data collection

This research aims to identify the influence of embodiment on VI purchase behaviour in new community VR games. Consequently, the conceptual model and resulting hypotheses were tested with players of the game "Zenith: The Last City". This is an MMORPG VR game, released in January 2022, in which players play and contribute to the improvement of this first version. In this game, players immerse themselves in an imaginary open world in VR, embodying an avatar. To progress, players carry out individual or team missions. Nevertheless, the community dimension of this game is important. The community facilitates the rapid development of players' skills through collective quests against characters generated by the game's algorithms. What's more, the VR controllers ensure total consistency between the player's real-life movements and the movements mediated in the game, encouraging virtual embodiment.

To study the impact of VR on embodied gamer behaviour, a link to a questionnaire was shared on several online gaming forums (owned by users of Zenith The Last City) and on the US and French Discord servers between February 2022 and September 2022. We followed up several times with the communities in order to obtain as many responses as possible. In order to overcome any concerns subjects might have about participating in the study (Podsakoff *et al.*, 2003), the survey was voluntary and confidential. In addition, subjects were given the opportunity to tick a box if they felt that the statements did not apply to them. This technique helps to minimise response bias, as respondents do not feel obliged to answer statements that have no meaning for them (Podsakoff *et al.*, 2003). In total, we collected 751 responses. However, after removing outliers and/or missing data from the collected database, we deleted 184 responses. Thus, 567 valid responses were used to test our hypotheses and measure the path coefficients of our structural equations.

4.2. Study measures and data analysis methods

The questionnaire contained 42 questions. The scales for the various concepts were taken from the literature, but very few studies have validated the scales developed for

belonging increases the purchase intentions of group members to actively participate in the community. Social belonging is linked to the Proteus effect and more specifically to the deindividuation mechanism it generates. Lea *et al.* (2001) state that anonymity increases an individual's attraction to the group. In this way, the individual self-stereotypes through the purchase of VI in order to align himself closely with the group.

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online VR games. We therefore took precautions when selecting the scales. All the measurement scales were initially developed in English. We translated each item into French. Experts in both languages then re-translated each measure into English. No significant differences were found between the original and translated items. We also checked the ease of understanding and the wording of each question with MMORPG players.

For the scale of the agency construct, most researchers have relied heavily on the scale developed by Witmer and Singer (1998), in which some researchers have noted certain inconsistencies (Slater, 1999). We preferred to opt for a more recent scale, that of González-Franco and Peck (2018), featuring three items and which, in our opinion, corresponds better to the 3D universe in VR. Concerning the ownership dimension, we preferred the three-item composite scale of Longo *et al.* (2008) to that of Kalckert and Ehrsson (2014) because the alpha coefficients are higher. The scales for social belonging were taken from the work on group belonging by Huang (2016). For the community commitment, we took the scale of Wu *et al.* (2010). Finally, the scale developed by Wu and Hsu (2018) was used for the VI purchase intention construct. The variables of the model are represented in the questionnaire by measurement scales from the literature and by a seven-point Likert scale (Strongly disagree = 1; Strongly agree = 7). All of the measures were reflective and assessed with seven-point Likert scales. In addition, subjects were offered the possibility to tick a box if they felt that the statements did not concern them. This technique helps to minimize response bias because respondents do not feel constrained to respond to statements that do not make sense to them (Podsakoff *et al.*, 2003). All items for each construct are listed in Table 2. The model was estimated using structural equations. Data analysis was performed using SPSS v28 and AMOS v26 software (Tables 2, 3, 4).

4.3. Participant profiles

The demographic analysis results are reported in Table 2. The sample was composed of 85.5% men and 14.5% women. Nearly 49% were still in high school at the time of the sample, while 29.9% had only a high school diploma. Thus, only 20.4% of the sample had a higher level of education. Holders of PhDs made up 0.7% of the sample. In terms of age

distribution, the majority of the sample was in the 22-27 age group with 50.6%. This is followed by the 22-24 and 28-30 age groups with 24.7% and 13.9% of the total sample, respectively. Furthermore, while players under 22 years of age represent only 8.1%, those over 27 made up 11.8% of the sample. This distribution corroborates an earlier study by Yee (2006), according to which MMORPG players are not predominantly children and teenagers. Table 1 gives an overview of the descriptive analysis of the analysis sample.

Table 2. Demographic analysis

	Classification	Frequency	Percentage
Sex	Homme	485	85.52
	Femme	82	14.48
	Under 12 years	1	0.29
	13-15	2	0.36
Age	16-18	7	1.3
	19-21	36	6.44
	22-24	140	24.73
	25-27	287	50.61
	28-30	79	13.96
	Over 30 years	12	2.2
	Without a diploma	54	9.6
Education	Certificate of higher studies of secondary	226	39.99
	Certificate of secondary studies of secondary	169	29.86
	Certificate of secondary studies +1	36	6.36
	Certificate of secondary studies +2	47	8.39
	Bachelor's	22	3.69
	Master's	8	1.23
	Doctorate	5	0.72

5. Results

5.1. Validity and reliability of measurements

A confirmatory factor analysis (CFA) was conducted using Amos 28 with all variables specified as unidimensional factors. The CFA model fit was acceptable ($\chi^2 = 1545.33$, $df = 50$, $p < .000$; $CFI = 0.91$, $IFI = 0.91$; $RMSEA = 0.05$). All factor loadings were statistically significant and above 0.70. We conducted tests on convergent validity, discriminant validity and construction reliability to test the validity of our instrument (Boudreau et al., 2001). Indeed, the average variance extracted (AVE) and composite reliability (CR) values were greater than 0.60 for all factors (see Table 3 & 4), demonstrating the convergent validity of the measurement (Fornell & Larcker, 1981). Also, discriminant validity measures the degree to which a construct is distinct from the others. It is assured when a construct shares more variance with its indicators than with the other constructs in the model (Hair et al., 2006). In other words, the square root of the AVE of each construct must be greater than the correlations of that construct with each of the other three. The correlation matrix on the right-hand side of Table 4 verifies that this condition is met: the numbers in bold in the diagonal represent the square roots. We observe that they are all superior to the correlations between constructs contained in other cells. Discriminant validity is therefore ensured for the four constructs used in this study (Fornell & Larcker, 1981). Convergent validity was assessed by cross-loading the items shown in Tables 3 and 4.

Table 3. Constructs and associated measurement indications

Latent constructs	Cronbach's Alpha (CA)	Kaiser-Meyer-Olkin (KMO)	Average variance extracted (AVE)
Agency (González-Franco & Peck, 2018)	0.712	0.761	0.580
Ownership (Longo et al., 2008)	0.855	0.872	0.755
Social Belonging (Huang, 2016)	0.601	0.747	0.459
Community Commitment (Wu et al., 2010)	0.841	0.743	0.748
Virtual items purchase intention (Wu & Hsu, 2018)	0.621	0.755	0.463

The results show that all items load properly onto their intended constructs, with higher values over 0.70.

Table 4. Discriminant validity based on Fornell-Larker criterion

Variables	Agency	Ownership	Social belonging	Community commitment	Virtual items purchase intention
Agency	0.762				
Ownership	0.152*	0.869			
Social belonging	0.163*	0.252**	0.678		
Community commitment	0.058	-0.056	-0.090*	0.865	
Virtual items purchase intention	0.223**	0.329**	0.277**	-0.178**	0.681

** Correlation is significant at the 0.01 level * Correlation is significant at the 0.05 level.

5.2. Testing the hypotheses

To examine the research hypotheses, we performed structural equation modelling (SEM), which simultaneously estimates the multiple relationships of the observed and latent variables and suggests the fit indices of the measurement model and the hypothesised model. We used AMOS 28 software to test all the model estimates, as we wanted to determine the paths between the variables. Before using structural equation methods based on maximum likelihood (SEM-ML), it was necessary to test the normality of all the variables in our model according to the recommendations of Hair et al. (2012). We performed a Kolmogorov-Smirnov normality test on the model's dataset by bootstrapping with Amos 28 with 1000 iterations. The results show that the data is not significantly different from a normal distribution, with a p-value of 0.20. This means that this type of modelling can be used in LISREL. Two other conditions also had to be met: non-autocorrelation of the measurement errors and non-correlation between the residuals of the latent variables. To meet and test these conditions, we assessed the multi-collinearity risks between

construct items. We found that all the VIFs are below the recommended threshold of 5 (Hair et al., 2012), indicating the absence of risk of multi-collinearity between the scales in the model. Given the very good overall values for convergent and discriminant validity and reliability, we can conclude that our instrument has adequate measurement properties. As Table 3 shows, the square roots of the AVEs for each construct (in bold in the table) are all greater than the correlations between the constructs.

Table 5 presents the descriptive statistics and the Pearson correlation analysis. To test the hypotheses, we performed a mediation analysis using AMOS 22 software. The results of the standardised path coefficients are shown in Figure 2. The model fit indices show that the model fits the data at an acceptable level. The chi-square test ($\chi^2/df = 7.008, p = 0.000$) is significant, indicating that there is a statistically significant difference between the observed and expected covariance matrices. However, the chi-square test is sensitive to sample size, so it is important to consider the other fit indices. The comparative fit index (CFI), incremental fit index (IFI), and Tucker-Lewis index (TLI) are all above 0.90, which indicates that the model is a good fit to the data. The root mean square error of approximation (RMSEA) is 0.062, which is below 0.08, which is also indicative of a good fit. The 90% RMSEA lower bound is 0.00, which further supports the conclusion that the model fits the data well. Overall, the model fit indices suggest that the model is a good fit to the data. There is some evidence of a lack of fit from the chi-square test, but the other fit indices are all above acceptable levels. Therefore, the researchers can be confident that the model provides a reasonable representation of the data.

The path diagram confirms the hypothesis posed by H2. The agency construct has a positive and significant impact on social belonging ($\beta = 0.127$ and $p < 0.005$). The structural links show that the ownership variable has a positive and significant impact on social belonging ($\beta = 0.238$ and $p < 0.001$), thus confirming hypothesis H4. Hypothesis H1 is also confirmed by the positive and significant influence of agency on community commitment ($\beta = 0.273$ and $p < 0.005$). Analysis of the relationship between ownership and community commitment in the game reveals a statistically positive and significant impact ($\beta = 0.244$ and $p < 0.001$; $\beta = 0.121$ and $p < 0.005$) thus validating hypothesis H3. Finally, analysis of the last links between community commitment and intention to purchase VI indicates a positive impact, thus confirming hypothesis H5. Furthermore, the direct effect of community commitment is positive and significant on intention to purchase VI ($\beta = 0.121$ and $p < 0.005$), confirming hypothesis H6. We also find that the impact of agency on social belonging and community involvement is greater than the impact of ownership. Furthermore, purchase intentions are positively impacted by community involvement and social belonging, confirming hypotheses H5 and H6. We note that the influence of community commitment on purchase intention is greater than that of social belonging ($\beta = 0.244$ and $p < 0.001$; $\beta = 0.121$ and $p < 0.001$ respectively).

5.3. Mediation analysis

Additional analysis: Mediating role of community commitment on virtual items purchase. This study

conducted data analyses using SPSS 28, augmented with PROCESS macro software, to test the mediating effect of authenticity (Hayes, 2013). As an additional analysis, we used a bootstrapping approach suggested by Preacher and Hayes (2008) to examine the indirect effects. We did bootstrapping tests with 5,000 bootstrap samples using AMOS (Preacher & Hayes, 2004; Hayes, 2013) to explore the mediation effect on the dependent variable of online booking intention. Finally, our results highlight the mediating effect of community

	Variables relationships	Estimation	S.E.	C.R.	Sig
Studied variables					
Agency =>	Social belonging	0.238	0.040	5.867	***
Ownership =>	Social belonging	0.127	0.047	2.710	**
Agency =>	Community commitment	0.273	0.038	7.112	***
Ownership =>	Community commitment	0.210	0.038	5.493	***
Social belonging =>	Virtual items purchase	0.121	0.046	2.615	**
Community commitment =>	Virtual items purchase	0.244	0.049	5.023	***
Control variables					
Age	Ownership	-0.144	0.053	-2.690	**
Age	Community commitment	0.124	0.048	2.595	**

commitment and social belonging between the independent variables of agency and ownership and the dependent variable of intention to buy VIs (Table 5). Furthermore, the mediating effect is stronger for community commitment than for social belonging.

The analysis of the relationship between agency and behaviour commitment shows that the total effect was $\beta = 0.262$, whereas the direct effect (after controlling for the mediator) was $\beta = 0.080$. This reduction in the β -weight confirms that community commitment mediated the effect of agency on VI purchase intention. In fact, the mediation was not statistically significant when the 95% confidence intervals contained zero ($p = 0.2495$, 95% bias-corrected confidence interval = [-0.0132, 0.1034]), thus, there is a mediating effect.

Table 5. Synthesis of the estimated relationships of the significance model

***: Significant at 1%; **: Significant at 5%

Table 6. Mediation effect of community

	B(SE)	95% Confidence Interval	
		ULCI	LLCI
Agency => Community => Virtual Items Purchase intention			
Standardized Direct effect	.021(13)	-.211	.311
Standardized Indirect effect	.241(03)	.011	.552
Total effect	.262(13)	.018	.234
Ownership => Community => Virtual Items Purchase intention			
Standardized Direct effect	.051(13)	.011	.487
Standardized Indirect effect	.029(04)	.031	.682
Total effect	.080(13)	.021	.501

Note: N = 567; Bootstrap sample size = 5000; Note : B: unstandardized effect; SE: standard error; ULCI: Upper limit of confidence interval; LLCI: Lower limit of confidence interval

6. Discussion, contributions, implications, limitations and perspectives

6.1. General discussion

The development of VR offers marketing and commercial opportunities (Wedel et al., 2020). Understanding the influence of this technology on user behaviour makes it easier for companies to exploit it (Wedel et al., 2020). In this context, our research investigates the

influence of virtual embodiment on the variables of community commitment, social belonging and VI purchase intention in VR MMORPGs. Four important conclusions emerge from this study. Firstly, VR technology modifies user behaviour (Flavián et al., 2020). The embodiment generated by this technology increases the sense of presence (Luangrath et al., 2022) and invites the player to engage with their community (Flavián et al., 2020). Secondly, virtual embodiment has a positive influence on the player's sense of social belonging to their community. Thirdly, the variables of community commitment and social belonging influence the player's purchasing behaviour. Fourth, highlighting the mediating effect of community commitment and social belonging between embodiment and VI purchase confirms the combined impact of these three variables on the purchase behaviour of the embodied player.

Concerning the analysis of the influence of virtual embodiment on the player's social behaviour, our results indicate that agency and ownership are antecedents that influence community commitment. VR immerses the individual in a state of flow and promotes engagement in the virtual universe (Chen & Lin, 2022; Fan et al., 2022). By actively controlling an avatar, the individual projects him- or herself and engages with his or her virtual community (Flavián et al., 2020), contributing to its success. Therefore, our work confirms previous studies on VR through tourism (Marasco et al., 2018; Leveau & Camus, 2023), culture (Allal-Cherif, 2022), entertainment (Wei et al., 2019) or commerce (Peukert et al., 2019), extending it to online multiplayer games. In addition, the individual's ability to interact with virtual elements (objects and avatars) in the same way as in the real world reinforces their sense of belonging to the virtual environment (Luangrath et al., 2022). VR allows players to identify more with their avatar and their community. This virtual identification increases trust (Kim et al., 2012) and strengthens the sense of social belonging through lasting virtual interactions (Haines, 2014). Our results confirm this approach and show that embodiment strengthens the player's sense of social belonging to their community. Finally, by demonstrating the benefits of embodiment on the attitudinal and behavioural transformations of the individual through the avatar, our work complements the existing literature on the Proteus effect (Ratan et al., 2020) by adapting it to VR game worlds.

In MMORPGs, the player constructs a virtual identity correlated to the expectations of their community (Shukla & Drennan, 2018). Our model confirms the important role played by the avatar in VI purchase intentions. Moreover, virtual embodiment increases the individual's imagination and desire to personalise virtual objects (Zhou et al., 2023) through purchase intention. Furthermore, our research reveals that community commitment and social belonging have a significant impact on VI purchase intentions. Therefore, our results echo the work of Kim, H.W. et al. (2012), Huang (2016) and Yahia and Chaabouni (2015) on the sense of virtual community, extending it to the world of VR MMORPGs. Our study extends previous research (Liu, 2016; Wang et al., 2019) and shows that social influences have an impact on players' overall behaviour, well beyond the intention to play. Finally, our results highlight that community commitment has a larger and more significant mediating

influence on purchase intentions than social group membership. Thus, it is by engaging in an active process of participation in the life and success of their community that gamers buy VIs to equip their avatars.

6.2. Theoretical implications

Through its originality, this research and its results make several important theoretical contributions to the academic world.

Firstly, our work broadens the scope of embodiment in VR universes and reveals that it can play an important role in these new community-based virtual universes. A large body of research investigates the impact of VR on user behaviour through technological affordances (Shin, 2017; Herz & Rauschnabel, 2019; Meißner et al., 2020; Zhou et al., 2023), enjoyment (Reer et al., 2022) or flow (Kim & Ko, 2019; Chen & Lin, 2022). Furthermore, although some researchers have explored the influence of communities on the behaviour of individuals across online universes (Abfalter et al., 2012), there is a lack of empirical studies on the evaluation of community influence in the context of VR universes. As such, the use of a VR MMORPG is an interesting field of study as community issues represent an important dimension in these multiplayer games (Mora-Cantallops & Sicilia, 2018). Moreover, most of the current studies focus on traditional 3D MMORPGs. Consequently, our work is, to our knowledge, the first to test the influence of this technology on the player's social and purchasing behaviour in this game environment. This study therefore evaluated a model based on the way in which VR influences the player's commitment and belonging to their community and, through a mediation effect, their intention to purchase VI. This model sheds light on a multifactorial mechanism that is still little analysed in academic research on this subject. Anchored in the approach of Flavián et al. (2019), our study complements and supports the idea that embodiment is an essential and idiosyncratic dimension of these new VR worlds and provides new keys to reading the development of virtual community feeling in these constituent universes of the metaverse.

Furthermore, our study is, we believe, the first to demonstrate the impact of the Proteus effect on player purchase behaviour in a VR MMORPG. Many studies on the Proteus effect focus on the effects of mutation and identity exploration offered by the avatar (Ratan et al., 2020). Thanks to VR, individuals really embody their avatar and project themselves into the virtual universe. Our research proposes to understand in greater depth the impact of embodiment on the intensification of links between the player, the avatar and the community. In the world of MMORPGs, many studies analyse player behaviour through motivations (Yee, 2007; Hassouneh & Bregman, 2014), emotions felt (Lee et al., 2020) and community norms (Cleghorn & Griffiths, 2015; Huang, 2016; Shukla & Drennan, 2018), but ultimately ignore the growing impact of this new immersive technology. Yet VR is a strong trend in video games (Reer et al., 2022) and the internet more generally.

Our model highlights a new possible convergence of several theoretical foundations relating to the purchase behaviour of the embodied player. This convergence is linked to the complementarity of the Proteus effect theory (Yee & Bailenson, 2007), the virtual community meaning theory

(Blanchard & Markus, 2004; Blanchard, 2007; Abfalter *et al.*, 2012) and the embodiment theory (Kilteni *et al.*, 2012). Consequently, our work not only enriches research on player behaviour in VR MMORPGs and more broadly VR worlds, but also extends the scope of the concept of embodiment. This research contributes to the recommendations issued by the academic community regarding the evaluation of the impact of VR on individual behaviour (Herz & Rauschnabel, 2019) and provides answers to the questions of Ratan *et al.* (2020) on the exploration of the Proteus effect in the context of VR.

6.3. Practical implications

This work has given rise to some interesting ideas for professionals wishing to offer immersive virtual environments. As mentioned earlier, our results show the importance of embodiment on player behaviour. As a result, publishers and developers should strive to integrate VR into multiplayer online games. More generally, this document invites professionals to be attentive to the advantages offered by VR in the construction of high-performance virtual community interfaces.

Firstly, it is necessary to design dynamic and immersive game solutions to accentuate the virtual embodiment of the player. Developers and publishers need to make their video games more realistic and capable of virtual anthropomorphism. Anthropomorphism is an important dimension in the use of new digital technologies (Van Doorn *et al.*, 2017). Developing virtual worlds composed of realistic virtual elements such as humanoid interactive virtual agents or avatars with a human appearance increases the individual's sense of social presence (Van Doorn *et al.*, 2017). The integration of high-performance technologies such as artificial intelligence promotes the deployment of these virtual elements in these virtual worlds (Huynh-The *et al.*, 2023). Thanks to embodiment, virtual presence is strengthened to the benefit of strong emotional experiences (Flavián *et al.*, 2020) and pleasurable experiences (Leveau & Camus, 2023). By being fully embodied in the game, players increase their importance in their virtual community, become more involved and buy VIs.

Secondly, professionals need to improve the player's experience by offering customisable interfaces. VR is a technology that encourages users to personalise their virtual environment through the purchase of VIs (Zhou *et al.*, 2023). This personalisation increases the interactivity of the player in the game and accentuates their immersion. The interactivity enabled by VR also influences the user experience (Bae *et al.*, 2020). Thanks to an intuitive interface, the player can easily and quickly interact with the virtual universe (Flavian *et al.*, 2019) and its community. This reinforces their pleasure and their intention to buy VIs (Wu *et al.*, 2022). In this context, professionals can set up icons enabling players to move easily from the game to the VI shop. They could also allow players to react to the look of other people's avatars, through small emoticons available in the game. Publishers could also offer ideas for personalising players' avatars by showcasing fashionable virtual objects or offering advice on virtual styling.

Thirdly, publishers must support strong links between players to consolidate solidarity and cooperation between them. This involves creating more engaging

community interfaces through team challenges (Lowe & Johnson, 2017), competitions between guilds and fluid, active audio chat systems. Furthermore, publishers need to develop exclusive social networking platforms specifically dedicated to these new virtual reality games in order to encourage players to maintain their links even outside gameplay phases and to strengthen attachment to the game and participative cultures (Bugress & Jones, 2020). This will ultimately strengthen the community tribalism of players with regard to the game and their community and thus encourage, on the one hand, repeated immersion and purchase by players in these new multiplayer game worlds and, on the other hand, positive word-of-mouth with regard to these games (Badrinarayanan *et al.*, 2014).

6.4. Limitations and future research

However, despite the interesting information on the possible explanatory variables of purchase intentions of VIs in 3D MMORPG, there are some limitations to our research. First of all, as previously mentioned, our model concerns an early game. Thus, this embryonic aspect of the game can necessarily lead to alterations in the results. In other words, the impact of the variables of the model analysed may evolve as the gameplay becomes more sophisticated. Secondly, our model is based on declarative data that may call into question its external validity. It could be relevant to conduct this same study on another more accomplished virtual reality MMORPG in order to confirm our results. Finally, there is a third limitation to this research in that the principle of localization (the third component of embodiment) has not been integrated into the theoretical model. Indeed, it could be possible that this component exerts a certain influence on the other two components of embodiment (agency and ownership) on the one hand, and on the analysis of community commitment and social belonging to a 3D MMORPG virtual community on the other.

Other future avenues of research remain to be explored in order to deepen our understanding of the purchasing behaviour of players in these virtual reality environments. In this respect, communities bring together many personalities with varying motivations. It could therefore be interesting to analyse the impact of members' personal motivations according to Yee's taxonomy (2007) on community commitment and ultimately on purchase intention. Another research perspective would be to measure the impact of the clan leader on the nature of the individual's community commitment and social belonging with regard to Tannenbaum and Schmitt's (1958) theory of the leadership continuum. Furthermore, as the avatar is intimately linked to the individual, the attachment to its virtual companion could influence its behaviour towards the community by limiting or reinforcing its personal commitment. In this respect, examining the impact of this attachment on the variables of community commitment and belonging may be a third relevant avenue for understanding the formation of purchase intentions. A fourth avenue of research could focus, following the example of Guadagno *et al.*'s (2011) work, on social evaluation in virtual environments, on assessing the impact of the avatar's appearance on the integration of the individual by other members of the community, and thus on the extent of his or her community

commitment and social belonging to the group. Finally, these multiplayer online games are directly mediated by computers or virtual reality headsets. The degree of individuals' commitment to the game and, consequently, their level of commitment to their community are inextricably linked to

their perception of the usefulness and ease of using this technology. Thus, understanding and measuring the effects of Davis's (1993) TAM (Technology Acceptance Model) on community commitment and purchase intention could be a fifth and final area of research.

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