Protecting Personal Space in Social Virtual Worlds: The Impact of Proximity-Control Features on Adoption Intention

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Figure 1: The personal space invasion scenario depicted in our study: (Left) first-person perspective of a user being approached by a stranger on the left; (Right) first-person perspective of a user being chased and blocked by the same stranger.

Abstract

Harassment and personal space invasions have been a core privacy threat in social virtual worlds from the outset, often causing lasting harm to victims and reducing their willingness to engage with these technologies. Media coverage of such incidents further amplifies fear and discourages potential users. In response, platforms have increasingly emphasized proximity-control features that allow users to protect themselves both preventively and reactively – most prominently through safety bubbles and avatar blocking. However, no study to date has examined whether these features influence adoption-relevant factors. To address this gap, we conducted a video vignette-based online survey with 195 participants in Germany, each exposed to a mild personal space invasion scenario under one of three conditions: no safety features, safety bubble, or avatar blocking. Results show that both safety bubbles and avatar blocking positively influence relevant adoption factors such as trust, controllability, satisfaction, and use intention. Safety bubbles additionally improved perceived safety and reliability, appearing to be the more effective solution due to their preventive nature. Finally, implications of the findings are discussed.

Index Terms: Social Virtual Reality (VR), Metaverse, proxemics, virtual territory, bullying, toxic behavior, interaction consent, privacy control, moderation tools, mute

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1 Introduction

Social VR and virtual worlds – also referred to as multi-user virtual environments and recently rebranded by industry as the metaverse – constitute virtual spaces designed to facilitate co-presence and shared experiences across physical distances [12, 13, 30]. They support a wide range of activities, including gaming, socializing, attending events, professional collaboration, and medical consultation [12, 25, 86]. Embodied and immersed through avatars, users can engage in social interactions that are perceived as realistic and socially meaningful [42], facilitating emotional and interpersonal connections such as friendship and romantic relationships [51]. Consequently, these platforms are increasingly considered for dating and intimate interactions [67].

Peer-to-peer harassment is a persistent issue in online social spaces and has long existed in social virtual worlds, with women, children, and minoritized users being primary victims [13, 16, 30, 70, 72]. Reports of sexual advances, harassment, and even rape date back to text-based virtual environments like Multi-User Dungeons in the 1990s [8, 25, 70]. A survey of over 600 regular users found that 49% of women and 36% of men had experienced sexual harassment or abuse, including groping, stalking, catcalling, and exposure to explicit content [8, 34, 35]. On platforms like VRChat, abusive behavior can occur as often as every seven minutes [30]. With the rise of social VR and the metaverse, concerns about personal space invasions have intensified, as the immersive nature of these platforms amplifies the psychological and emotional impact compared to traditional platforms [8, 16, 42, 49, 68, 88].

Harassment is commonly defined as a behavior that continues despite a victim's request to stop [8]. In social virtual worlds, it often takes forms of non-consensual interactions with a victim's avatar [43]. Such experiences have negative spillover effects into victims' offline lives, causing emotional distress, altering technology use, and heightening concerns about safety and privacy [8, 16]. Research highlights such fears over privacy-related issues as major barriers to adopting social platforms [19].

Moreover, harassment in social VR and virtual worlds has also received considerable media attention, with alarming headlines such as "virtual groping", "virtual sexual assault", and "virtual rape" appearing in mainstream news (e.g., [36, 47]) and prominent tech blogs (e.g., [6, 7]). These reports frequently involve harm to vulnerable groups, such as women and children, highlighting both the realism of such encounters and the emotional distress they cause. Numerous incidents are further documented on social media platforms such as Reddit [8, 25], and a growing number of videos depicting such incidents are circulating on YouTube [51].

While online media serves as an important coping outlet for harassment victims, enabling them to voice their grievances, seek support, and assert their rights [28], it also shapes broader public perceptions of social virtual worlds. Exposure to safety-related threats on social media can also heighten an individual's concern for their own safety [52]. Consequently, these harassment scandals related to social virtual worlds may negatively affect individuals' attitudes and lead to avoidance and resistance toward adapting these technologies. As in physical worlds, people tend to avoid activities in unsafe environments [60].

Because harassment in social virtual worlds, like on social media, is technology-mediated, effective system design can help deter it [27, 40, 87, 88]. Unlike physical spaces, virtual worlds are not constrained by physical laws and can be dynamically adjusted in their visual, auditory, and spatial properties [46]. Experts therefore advocate the use of proxemics to regulate social interactions, including personal space controls and explicit consent mechanisms [30]. Over time, platforms have introduced diverse safety features. The most prominent are the safety bubbles, which create invisible protective zones around users, and avatar blocking, which prevents selected users from interacting or been seen and heard [42].

While prior research has primarily focused on harassment experiences [8, 16, 25, 37, 51] and platform moderation strategies [15, 35, 38] in social VR and virtual worlds, proximity-control features have only recently begun to attract scholarly attention [26, 42, 67]. However, little is known about how the availability of such features influences user adoption intentions. To address this gap, our study examines perceptions of proximity-control features, specifically safety bubbles and avatar blocking, and their influence on key adoption-related factors of social virtual worlds, namely perceived trust, safety, reliability, controllability, satisfaction, and use intention. We further compare these perceptions across different conditions. Accordingly, we pose the following research question: ***How do proximity-control features in social virtual worlds affect user perceptions of adoption-relevant factors compared to environments without such features?***

To address this question, we conducted a between-subjects online vignette study with 195 participants in Germany. This method enables the investigation of respondents' beliefs, attitudes, and judgments in a controlled procedure [3]. We created three video-based vignettes using Roblox depicting a realistic virtual proximity invasion scenario, as shown in Fig. 1, under three conditions: (V1) no proximity-control feature, (V2) a preventive safety bubble, and (V3) reactive avatar blocking. Participants were randomly assigned to view one of the vignettes and asked to evaluate it.

2 Background

2.1 Proxemics

The theory of proxemics, introduced by Hall [18], explains how humans use space and distance to communicate and regulate social interactions. It describes how people use their senses such as sight, sound, touch, and smell to determine a comfortable physical distance for face-to-face interactions [64]. This distance forms an invisible three-dimensional bubble around a person, serving as a protective zone that regulates contact, reduces stress, and helps control social aggression [62, 64, 66].

Hall [18] distinguishes four proxemic zones, ranging from closest to farthest from the body: intimate, personal, social, and public. The intimate zone is reserved for intimate relationships and physical contact like hugging and touching [62]. It allows close visual focus on another person's face. The personal zone is typical for friends and family, permitting occasional contact and clear perceptions of nonverbal cues [18]. The social zone applies to formal or unfamiliar interactions, minimizing physical contact while allowing cautious observation of the whole body [64]. Finally, the public zone is reserved for larger audiences, where facial details and voices become less perceptible [18].

Most people have an innate need for personal space, which they perceive as a psychologically protected territory that moves with them [18]. Preferred distances vary by context, culture, and individual behavior [62, 64]. Intrusions typically elicit irritation or discomfort [62]. The inherent need for personal space extends to virtual environments [44, 61, 65], where users similarly maintain culturally appropriate interpersonal distances [69]. Similar to the physical world, personal space in virtual environments typically forms a circular zone with a radius of about one meter [20]. These observations underpin research on digital proxemics, which examines how spatial behavior in virtual environments is shaped by the presence of others, building on principles of physical proxemics [45, 46, 68]. Violations of personal space, whether real or virtual, can induce emotional arousal and discomfort [44].

2.2 Proximity Invasion as Basis of Virtual Harassment

Harassment in social virtual worlds can be categorized into visual, verbal, physical and sexual dimensions [8, 42] and can generally be understood as invasions of proxemic zones [87].

Visual harassment typically occurs through public zone invasions, including unwanted exposure to offensive or disturbing content such as text, images, videos, or 3D models. Typical examples include offensive avatar designs, such as avatars wearing pornographic clothing or performing sexual gestures like self-gratification [35, 67], as well as virtual scaring or displays of violent or sexual content [8, 30, 42, 74]. Due to system constraints, such harassment generally requires spatial proximity, since avatars and their content are only rendered within the victim's public zone. This category also includes virtual stalking, where perpetrators repeatedly follow victims across virtual spaces [25, 35, 42].

Verbal harassment primarily occurs through social zone invasions, as social virtual worlds often employ proximity-based voice chat to mimic offline interaction, requiring close spatial proximity to be heard. This category includes insults, threats, hate speech, sexualized language, and voice trolling [8, 30, 42, 51, 67]. Racist, sexist, homophobic, and transphobic language is widespread [30]. This category also covers disruptive noises like yelling or loud, unpleasant sounds ("ear rape") [35].

Personal zone invasions involve disruptive avatar movements or object placement, including running through avatars to interrupt conversations and positioning avatars or objects to obstruct paths, entrances or views [16, 30, 35, 42]. While some incidents stem from user inexperience [8] or idle avatars [35], others are deliberate. For instance, bullying groups exploit avatar hitboxes to "box in" victims, blocking vision and overwhelming them with disruptive noises [35, 42]. Such behaviors can leave users feeling powerless.

Intimate zone invasion is the most severe form, often involving violations of bodily autonomy through non-consensual touching or groping that simulates physical or sexual assault, such as slapping, throwing virtual objects at other users, or forced kissing [8, 25, 30, 35, 42, 51, 67]. The harm is amplified when haptic devices translate these actions into physical sensations [30].

2.3 Safety Bubble

A key strategy to protect users in social virtual worlds is preserving their personal space, as harassment often arises from unwanted intrusions into an avatar's proximity. A widely used preventive solution is the safety bubble (also known as "personal space bubble" [26, 30] or "intimacy proxemics" [42]), implemented on platforms like VRChat, RecRoom, Horizon Worlds, and Spatial [25, 30, 42]. The safety bubble is an invisible protective zone around a user's avatar that renders intruding avatars invisible and inaudible [30], preventing unwanted touches, speech, or interactions [68]. Unlike physical barriers, it does not restrict user movement but enforces a minimum distance for interaction, protecting users from harassment and enabling smoother navigation in crowded settings by preventing avatars from obstructing visibility [25, 26, 30, 42].

Safety bubble designs may vary across platforms. The simplest form uses a fixed radius around the avatar, while newer implementations adapt to avatar shapes [26]. Many platforms also allow users to customize bubble size and permissions, such as letting friends bypass the barrier [30]. For instance, in Meta Horizon, the safety bubble is enabled by default for non-friends, preventing them from approaching closer than four feet [25]. Users can also adjust the setting to apply to everyone or disable it entirely.

2.4 Avatar Blocking

Unlike safety bubbles, which are less frequently used due to limited user familiarity, reactive tools like avatar blocking are more common, as users know them from online games and social media [42]. Blocking serves as an ad-hoc response to unwanted attention or abuse [30, 42], typically hiding and silencing selected avatars [35], while preventing the blocked user from seeing and hearing the blocker. Indirect interactions are also restricted, as blocked users often cannot send messages or requests to the blocker.

Many users consider avatar blocking as the default response to harassment in social virtual worlds, describing it as simple, quick, and effective, especially against verbal abuse [42]. Its effects are immediate and observable [42]. All major platforms, including VRChat, RecRoom, Horizon Worlds, Spatial, and Roblox, offer avatar blocking [30, 42], though implementations vary. For example, Roblox does not render blocked users invisible, while Meta Horizon Worlds shows them as featureless grey avatars. Moreover, RecRoom allows activation via hand gestures and separates conflicting users in future sessions [35, 42].

3 Hypotheses

3.1 Trust in the Social Virtual World

Technology adoption is strongly influenced by trust, which shapes users' beliefs and behaviors toward a system [4, 31]. To engage in online activities, users must hold a basic level of trust in the technological environment, which can vary by activity [11]. This trust reflects their belief in the reliability and integrity of the system for performing specific tasks [11]. Trust facilitates engagement in online activities like transactions and interactions, while a lack of trust often leads to avoidance and disengagement [19, 22]. In social virtual worlds, harassment and personal space invasions can increase perceived privacy and security risks, reducing trust in the environment. In contrast, safety features and privacy protections can enhance trust in technology-mediated environments [4, 11]. When users trust the environment, they are more likely to discount potential threats and risks, experience lower stress, and feel more confident in engaging [11]. We therefore propose:

H1. Social virtual worlds equipped with proximity-control features will elicit higher trust compared to those without.

3.2 Perceived Safety

Safety perceptions are cognitive responses triggered when individuals perceive external threats and feel at risk [5, 52]. Perceived safety reflects an individual's subjective sense of being safe in a given environment, situation, or while using a system. Originally studied in physical contexts, it is often linked to threats such as violence, disease, or predatory behavior [53]. Lower perceived safety associates with avoidance and reduced engagement [52]. More recently, safety perceptions have been examined in digital contexts, including social platforms, to assess users' perceived protection against targeted privacy and security threats [53]. In social virtual worlds, harassment and personal space invasions can increase users' generalized fear of crime and victimization, reducing their perceived safety [52, 73]. Proximity-control features, however, offer mechanisms to prevent or respond to such misconduct, enhancing users' sense of personal space protection in virtual environments. Accordingly, we propose:

H2. Social virtual worlds equipped with proximity-control features foster higher safety perceptions compared to those without.

3.3 Perceived Reliability

Perceived reliability is the belief that a system is trustworthy and performs consistently well [50]. In interpersonal contexts, it reflects confidence that social or financial transactions can be successfully completed without disruption, creating a sense of security in those involved [50]. For technology adoption, it denotes the belief and confidence that a system will operate and function properly and consistently over time [31], with higher perceived reliability increasing adoption likelihood. In social virtual worlds, relying on safety features that prevent or manage harassment and personal space invasions is crucial. Proximity-control features allow users to protect themselves against unwanted interactions, enhancing their confidence. Thus, we propose:

H3. Social virtual worlds equipped with proximity-control features will elicit higher reliability perceptions than those without.

3.4 Perceived Controllability

Perceived behavioral control refers to the extent to which individuals believe they have control over performing a given behavior [19]. This belief is shaped by resources and opportunities they perceive as available [2]. People are more likely to engage in behaviors and adopt technologies they feel they can control, and less likely to attempt those they perceive as uncontrollable [19]. Moreover, perceived control affects how individuals experience environments where harassment may occur, influencing whether such events are seen as within or outside of one's personal control [23]. In social virtual worlds, proximity-control features serve as resources that enhance users' perceived control over their personal space. These tools enable users to manage personal space invasions and choose with whom they interact. Therefore, we assume:

H4. Social virtual worlds equipped with proximity-control features will induce a greater sense of control over personal space among users than those without.

3.5 Perceived Satisfaction

User satisfaction reflects a person's overall evaluation of their experience with a digital system, including how well it meets their needs and desires [9]. It is shaped by both cognitive factors, such as perceived usefulness and expectation confirmation, and affective factors, such as enjoyment and distress [33]. Satisfaction is a key predictor of user engagement and technology adoption [9]. Negative experiences, including harassment and personal space invasions, can undermine perceived usefulness and enjoyment, thereby reducing overall satisfaction [10]. By integrating proximity-control features, users are better protected from such

negative experiences, allowing them to engage more freely with both hedonic (e.g., entertainment) and utilitarian (e.g., work) aspects of social virtual worlds. Therefore, we anticipate:

H5. Social virtual worlds equipped with proximity-control features will achieve higher user satisfaction than those without.

3.6 Use Intention

Behavioral intention refers to an individual's perceived likelihood of engaging in a specific behavior in the future [2] and is widely considered a key predictor of actual behavior, including technology adoption [41]. In this context, intentions to adopt and use social platforms are negatively affected by technology-related stress [29], particularly privacy-related threats [32], which can lead to avoidance intentions and withdrawal from otherwise beneficial services [11]. In social virtual worlds, harassment and personal space violations constitute salient privacy threat [49] that evoke negative emotional responses and foster disengagement tendencies [11]. Proximity-control features can help users manage technostress arising from such experiences. Therefore, we expect:

H6. Social virtual worlds equipped with proximity-control features will trigger higher use intentions than those without.

4 Methodology

We conducted a between-subjects online vignette study to examine user perceptions of proximity-control features in a personal space invasion scenario within social virtual worlds. Participants were randomly assigned to one of three vignettes, each depicting different proximity-control conditions and asked to evaluate them.

A vignette study using Roblox-based video recordings was chosen over real VR exposure to harassment to prevent unnecessary harm to participants and ensure ethical research practices. This method involves presenting participants with realistic, hypothetical scenarios (i.e., vignettes), in our case in form of video recordings, to elicit their attitudes and judgments, thereby assessing dependent variables [3]. Vignettes enhance contextual realism compared to standard surveys, allowing for the manipulation and control of independent variables, maximizing both internal and external validity [1]. Video recordings are common for studying proxemic invasions, such as shoulder surfing, as they allow the depiction of representative scenarios and provide a reliable baseline when creating realistic, real-time experiences is difficult or unethical [82, 83]. Popular platforms like VRChat, Rec Room, and Roblox are accessible via both 3D head-mounted displays (HMD) and 2D mobile or desktop devices, making 2D videos suitable stimuli for virtual proximity research. Although movement and navigation differ across modalities, social interactions are governed by same social norms [84]. Video-based stimuli also ensure high consistency across participants compared to interactive approaches [82]. Moreover, their plug-and-play nature enables the inclusion of both experienced users and non-users without requiring prior knowledge of device-specific controls [82], reducing participation barriers and potential onboarding challenges for novel technologies [45].

4.1 Vignette Design

We designed three video vignettes to depict a realistic personal space invasion in social virtual worlds. While all three show the same scenario, they differ in the implemented safety feature shown, either no safety feature (V1), safety bubble (V2) or avatar blocking (V3), as shown in Fig. 2. The scenario was created in Roblox Studio using prescripted interactions. These interactions were screen-recorded and presented as videos. To ensure consistency, UI designs were kept simple and minimalistic across all vignettes. Furthermore, all videos were exactly two minutes long.

The scenario depicts a first-person perspective of a user at a crowded virtual concert. Upon entering a club, the user hears music

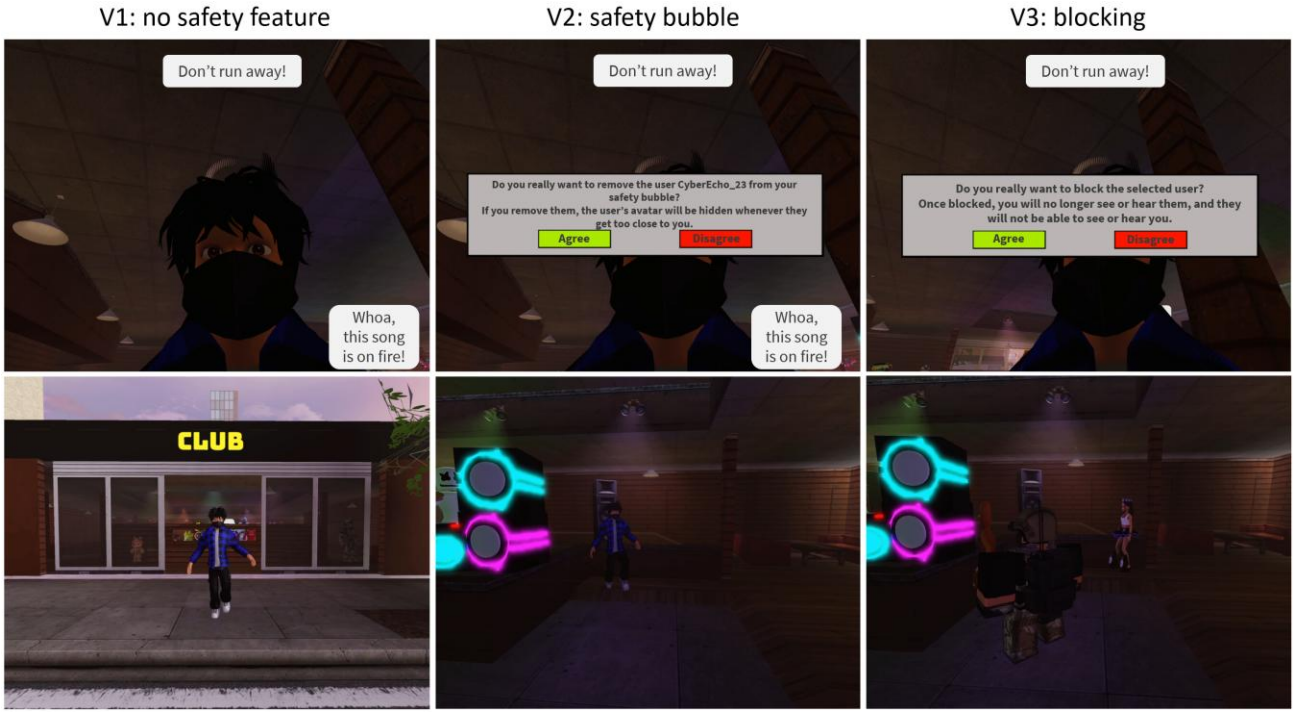

Figure 2: Comparison of three vignettes: (Left) a personal space invasion scenario without safety features; (Middle) the same scenario with a safety bubble, rendering the harasser and strangers invisible within the user's personal space; (Right) a blocking feature, which makes the harasser fully disappear from view.

and sees avatars dancing and socializing. The user moves to an open area on the dance floor to enjoy the DJs' performance. Shortly after, a stranger appears in the user's peripheral vision, approaches uncomfortably close, blocks the view, and invades personal space. The stranger initiates contact, asking if the user regularly visits the club. Disturbed, the user moves to a less crowded area to avoid unwanted interaction, but the stranger follows, blocks the view again, presses their avatar against the user's, and insists on befriending them. Increasingly distressed, the user leaves the dance floor to preserve personal space and avoid further unwanted interaction. Yet, the invader continues to follow, gets uncomfortably close, and demands the user to not run away.

V1: Without safety features, the user must flee to avoid unwanted contacts. When attempting to escape, the user leaves the club, but the invader continues the chase outside, ultimately forcing the user to exit the social virtual world. Avoidance was chosen as the coping strategy as withdrawal from interactions is the most common response and immediately ends the uncomfortable experience [76, 79, 80], whereas confrontation requires greater cognitive and emotional effort and may provoke backlash, potentially escalating the situation and increasing discomfort [37, 76, 77, 78].

V2: Unlike the prior vignette, this vignette features a safety bubble that automatically prevents strangers from entering the user's personal space. Thus, when the stranger initially approaches, he becomes invisible to the user upon crossing the bubble boundary. A permission request from the stranger then appears, asking to become visible and audible for interaction within the user's personal space. This is accepted to let the invasion to unfold. The subsequent sequences mirror the previous vignette until the user is chased off the dance floor, at which point the permission is revoked. A confirmation pop-up indicates that the invader will become invisible and inaudible if too close, and upon confirmation, the invader disappears. Returning to the dance floor, the invader reappears at a distance but becomes invisible again upon re-entering the bubble, allowing the user to continue enjoying the club. The safety bubble had a radius of 15 Roblox units [81] along the x-, y-, and z-axes. The participant's avatar measured 2.4, 6.25, and 1.1 units in the x-, y-, and z-dimensions, respectively. The bubble was centered on the avatar's body to ensure full enclosure.

V3: In this vignette, the user activates a reactive blocking feature on the invader. A confirmation notification appears, stating that after blocking, both avatars will become invisible and inaudible to each other. The user confirms, and the invader disappears from the user's view. The user then returns to the dance floor, confirms the absence of the harasser, and continues enjoying the experience.

4.2 Measures

4.2.1 Demographics

For demographic data, we collected participants' gender, age, general education level, and employment status. To assess social virtual world experience, we asked about VR headset ownership and the experience of prior VR usage and online multiplayer games.

4.2.2 Evaluation of Proximity-Control Features

To evaluate proximity-control features, participants viewed video vignettes with the respective feature and then reported their perceptions of trust, safety, reliability, controllability, satisfaction, and use intention of the depicted social virtual world. These constitute the dependent variables of our study and were measured using self-developed single-item questions on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), (see Tab. 1).

We opted for single-item measures due to their practical advantages in terms of cost-efficiency, simplicity, and ease of administration compared to multi-item measures [58, 59]. This approach helps to avoid dropout rates caused by over-surveying and inappropriate response behavior, such as fatigue, boredom and inattention, which increase susceptibility to bias and limit external validity [57, 58]. Furthermore, research suggests that carefully designed single-item measures for well-defined, concrete constructs can be as valid as multi-item scales [56].

In our case, as described in section 4.3, the employed single-item measures were iteratively developed and evaluated in pre-tests by a team of experts to ensure the use of simple language, short and specific wording, neutral phrasing and one-dimensionality. This was done to comply with standard guidelines for item construction.

Table 1: Measurements

Variable	Item
Trust	If you were in the situation shown, to what extent would you feel you could trust the virtual world?
Safety	If you were in the situation shown, how safe would you feel in the virtual world?
Reliability	If you were in the situation shown, how reliably could you have prevented unwanted physical proximity?
Controllability	If you were in the situation shown, to what extent would you feel you had control over who could approach you?
Satisfaction	If you were in the situation shown, how satisfied would you be with the solution to avoid unwanted proximity by: • V1: running away and logging out of the virtual world? • V2: using a safety bubble? • V3: blocking other users to prevent you and the blocked users from seeing or hearing each other?
Use intention	How would your future use intention of the virtual world change if you could avoid unwanted proximity by: • V1: running away and logging out of the virtual world? • V2: using a safety bubble? • V3: blocking other users to prevent you and the blocked users from seeing or hearing each other?

4.2.3 Knowledge and Relevance of Proxemic Invasion

To assess participants' general familiarity and perceived relevance of the research topic, we asked how familiar they were with proxemic invasions in social virtual worlds and how important they considered the protection of personal rights in such settings. Responses were measured on a five-point Likert scale ranging from very unimportant (1) to very important (5).

4.3 Pretesting

The survey underwent rigorous pre-testing with fifteen experts in consumer protection, law, privacy, social virtual worlds, and HCI. Across three major revision cycles, experts provided qualitative feedback on the plausibility and accuracy of the vignette designs, which were refined accordingly. Additionally, all single-item questions were reviewed and iteratively improved in collaboration with the expert group. Multiple pilot tests were conducted to ensure clarity, relevance and alignment with the research objectives.

4.4 Procedure

Given the sensitive nature of the study, particularly regarding personal space invasion, participants were informed in advance about the purpose and procedure, including that they would watch a video vignette that might feel uncomfortable and distressing. Individuals with highly negative prior experiences in interpersonal interactions were advised not to participate. Participants were reminded that the participation was entirely voluntary, with the option to withdraw at any time without consequences, and compensation was provided regardless of survey completion. As a precaution, participants also received information on where to seek support should they feel the need. Informed consent was obtained from all participants before the study began.

The study began with demographic questions, followed by a brief definition of proxemic invasions in our research context. Participants then indicated their familiarity with and relevance perceptions of the topic. They were then instructed to enable the audio on their devices, since the video stimuli included auditory components. Following this, they were randomly shown one of the three vignettes, with the option to rewatch it. Finally, they evaluated it by completing a survey assessing the dependent variables.

4.5 Participants

To strive for diversity, participants were recruited in February and March 2025 via a Germany-wide consumer panel managed by a market research institute, designed to be population-representative. The panel included individuals aged 20 years and older residing in Germany and possessing fluency in the German language. Participants took approximately 8 to 10 minutes to complete the survey and were compensated with €1.20.

After excluding invalid answers as well as overly fast and slow participants, the final sample comprised 195 valid responses, with 65 in each condition. An a priori power analysis (GPower 3.1.9.7) indicated that 159 participants were required for the planned analysis using one-way ANOVA with three groups ($f = 0.25$, $\alpha = .05$, power = .80), a criterion which was satisfied by our sample.

The final sample was balanced in terms of age and gender. Age distribution covered all adult decades from 20 to 80 years, with approximately 30 participants per decade. Moreover, 46% of the participants identified as male and 54% as female. Of the participants, 69% were employed, either full- or part-time. A further 24% were retired, while only a minority were either in education (2%) or unemployed (6%). The level of general education was mixed, with 57% of the participants having completed A-levels and 43% having completed medium or lower secondary education.

In terms of VR experience, only 24% of participants reported owning a VR headset. However, 41% had previously used one, and 46% had prior experience of 3D online multiplayer games. Chi-square tests on demographic variables confirmed that participant characteristics were evenly distributed across different conditions, indicating that random assignment was successful.

5 Results

We conducted one-way ANOVAs to test our hypotheses, using Jamovi 2.6.26 and an alpha level of $\alpha = .05$. The assumptions were checked using the Shapiro-Wilk test and Q–Q plots for normality and Levene's test for homogeneity of variance. These revealed that some dependent variables did not meet these assumptions. Since F-tests are generally robust against violations of normality [55], we used Welch's ANOVA, which is also robust against unequal variances [54]. Post hoc comparisons were conducted using Games–Howell tests, which are also suitable for cases of unequal variance. The results are visualized in Fig. 3.

Trust. The analysis revealed a significant difference in trust across the three vignettes ($F(1,128) = 9.88$, $p < 0.001$). Post hoc tests indicated that the safety bubble ($M = 3.29$, $SD = 1.17$, $p < 0.001$) and avatar blocking ($M = 3.00$, $SD = 1.25$, $p = 0.014$) provided significantly more trust than the no-feature vignette ($M = 2.40$, $SD = 1.16$). No significant difference in trust was found between the safety bubble and avatar blocking ($p = 0.356$).

Safety. The analysis revealed a significant difference in safety across the three vignettes ($F(1,128) = 7.31$, $p < 0.001$). Post hoc tests indicated that the safety bubble ($M = 3.62$, $SD = 1.13$) was rated significantly higher in terms of safety compared to the no-feature vignette ($M = 2.82$, $SD = 1.25$, $p < 0.001$). No significant differences were found between the no-feature vignette and avatar blocking ($M = 3.25$, $SD = 1.30$, $p = 0.135$) as well as between the safety bubble and avatar blocking ($p = 0.198$).

Reliability. The analysis revealed a significant difference in reliability across the three vignettes ($F(1,125) = 11.20$, $p < 0.001$). Post hoc tests indicated that the safety bubble ($M = 3.92$, $SD = 0.99$) was rated significantly more reliable compared to the no-feature vignette ($M = 3.09$, $SD = 1.26$, $p < 0.001$) and avatar blocking ($M = 3.17$, $SD = 1.36$, $p = 0.001$). No significant difference was found between the no-feature vignette and avatar blocking ($p = 0.940$).

Controllability. The analysis revealed a significant difference in controllability across the three vignettes ($F(1,128) = 9.06$, $p = <0.001$). Post hoc tests indicated that the safety bubble ($M = 3.62$, $SD = 1.23$, $p < 0.001$) and avatar blocking ($M = 3.37$, $SD = 1.32$, $p = 0.010$) provided significantly more controllability than the no-

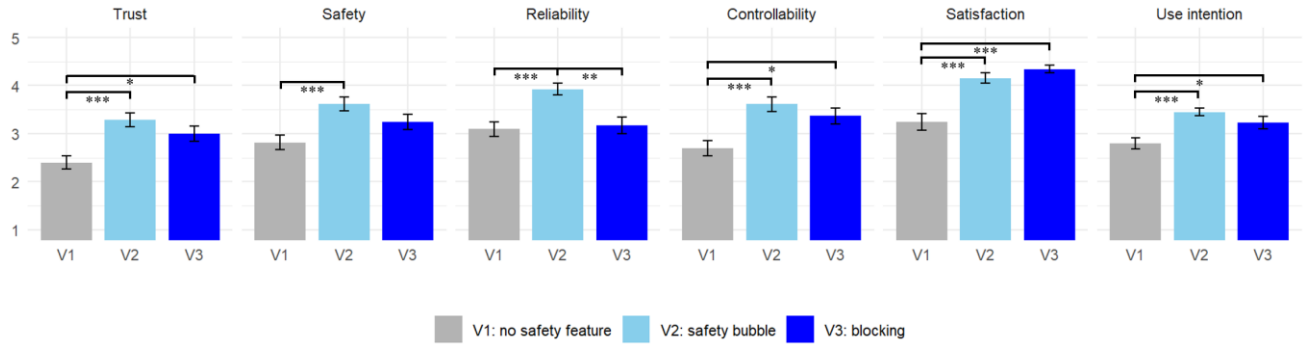

Figure 3: Bar chart displaying mean ratings of Trust, Safety, Reliability, Controllability, Satisfaction, and Use intention across the three vignette conditions. Error bars indicate standard errors of the mean. Significance levels from post hoc tests are denoted as follows: * $p < .05$, ** $p < .01$, *** $p < .001$.

feature vignette (M = 2.69, SD = 1.30). No significant difference was found between the safety bubble and blocking ($p = 0.516$).

Satisfaction. The analysis revealed a significant difference in satisfaction across the three vignettes ($F(1,119) = 16.84$, $p < 0.001$). Post hoc tests indicated that the safety bubble ($M = 4.15$, $SD = 0.87$, $p < 0.001$) and avatar blocking ($M = 4.34$, $SD = 0.64$, $p < 0.001$) provided significantly higher satisfaction than the no-feature vignette ($M = 3.25$, $SD = 1.37$). No significant difference was found between the safety bubble and avatar blocking ($p = 0.357$).

Use intention. The analysis revealed a significant difference in use intention across the three vignettes ($F(1,122) = 11.01$, $p < 0.001$). Post hoc tests indicated that the safety bubble ($M = 3.45$, $SD = 0.64$, $p < 0.001$) and avatar blocking ($M = 3.23$, $SD = 1.03$, $p = 0.033$) evoked a higher future use intention than the no-feature vignette ($M = 2.80$, $SD = 0.91$). No significant difference was found between the safety bubble and avatar blocking ($p = 0.326$).

5.1 Knowledge and Relevance of Proxemic Invasion

The majority of participants (57%) were familiar with the topic of proxemic invasion in social virtual worlds, 32% had briefly heard of it, and only 11% had no prior exposure to the topic.

91% of participants indicated that protecting personal rights in social virtual worlds is important or very important, while 2% had a neutral attitude and 7% found it (very) unimportant.

6 Discussion

In this study, we examined whether safety features designed to manage proximity-based invasions can enhance perceptions of factors predicting technology adoption, specifically perceived trust, safety, reliability, controllability, satisfaction, and use intention of social virtual worlds. We compared three scenarios respectively featuring a personal space invasion without safety features, with the preventive measure of a safety bubble, and the reactive measure of avatar blocking. We tested this using a between-subjects vignette-based online study with 195 participants in Germany.

The results indicate that our hypotheses H1, H4, H5, and H6 were fully supported, as proximity-control features – both safety bubbles and avatar blocking – significantly increased user perceptions of trust, controllability, satisfaction, and use intention compared to the vignette condition with no safety feature. Hypotheses H2 and H3, however, cannot be fully supported. While the safety bubble also improved perceptions of safety and reliability, the version with avatar blocking did not. These findings are discussed in detail in the following sections. A direct comparison between safety bubbles and blocking is presented in sections 6.3 and 6.4.

The contributions of this paper are as follows: (1) we present initial evidence on the role of safety features in shaping adoption-related perceptions of social virtual worlds, (2) we offer an empirically grounded comparison of preventive and reactive safety features by directly contrasting safety bubbles and avatar blocking, (3) we contribute methodologically to research on safety features in social virtual worlds by collecting immediate responses to controlled video stimuli from a diverse population sample.

6.1 The Importance of Virtual Personal Space

Our study shows that proximity invasion in social virtual worlds is a widely recognized concern, with most participants emphasizing the relevance of protecting personal rights in virtual environments. We provide empirical support for the concept of digital personal space, showing that individuals value their virtual proxemics in ways comparable to physical ones [45, 46]. Control over interactions within one's virtual territory reflects the fundamental human tendency to claim and defend personal space [49, 61], as the area surrounding an avatar is often experienced as psychologically owned and emotionally salient [61]. While prior virtual proximity research has largely focused on immersive 3D environments accessed via HMDs [20, 44, 45, 85], our findings show that personal space perceptions are also highly relevant in less immersive desktop-based virtual worlds. Although users in such environments may be less sensitive to social cues and spatial awareness than in immersive VR [46], personal space violations still elicit discomfort and require protection, as social interactions are governed by the same social norms regardless of the mode of environmental depiction [84]. Without adequate safety features, virtual personal space violations can negatively affect cognitive and emotional responses, much like physical proximity violations [8].

6.2 Safety Features and Adoption Intention

Our study extends research on trust in and adoption of social VR and virtual worlds, where frequent peer-driven privacy invasions can range from annoying to traumatizing, causing technology-related stress and reducing users' willingness to engage [29, 32]. To our knowledge, no prior research has examined how the presence of safety features affects adoption-related perceptions. Our findings provide initial evidence that safety features can enhance key factors influencing the adoption of social virtual worlds, including trust, safety, reliability, controllability, satisfaction and use intention.

We show that harassment and personal space invasions in social virtual worlds are technology-induced problems that can be mitigated through effective IT design [27, 40, 87, 88]. Unlike in the physical world, safety features in virtual environment can empower victims to mitigate harassment, promoting a greater sense of justice. Embedding safety features can reduce user exposure to unpleasant incidents and mitigate related negative emotional responses.

Following the recent stagnation in adoption after the hype surrounding the rebranding of social virtual worlds as the metaverse, safety features may play a decisive role in attracting and retaining broader user groups. Integrating these features can make social virtual worlds safer and more trustworthy, encouraging greater participation and diversity [73]. They can particularly safeguard children [72] and enhance the confidence of women and minority users, who might otherwise be hesitant to engage in these virtual spaces due to safety concerns [16, 73]. While many platforms already offer safety features, their availability and functionality should be more actively communicated. Our findings indicate that potential users value a sense of safety and protection from misconduct, similar to expectations in physical spaces [60].

6.3 Safety Bubble as a Tool for Consented Interaction

Compared to the no-feature condition, avatar blocking significantly improved trust, controllability, satisfaction, and use intention, but did not enhance perceived safety or reliability. When comparing the safety bubble with avatar blocking, no significant differences emerged across most measures except reliability, which was rated higher for the safety bubble. This likely reflects the reactive nature of avatar blocking, which can only be applied after an invasion has already occurred, limiting its effectiveness [42] and sustaining the belief that harassment and personal space invasions in social virtual worlds are inevitable [42]. Moreover, reactive measures depend on users' ability to respond promptly [68]. Social threats in VR can elicit a "freezing" state – reduced heart rate and postural mobility – especially when haptic feedback is applied [68, 75], potentially delaying users' ability to activate avatar blocking.

In contrast, the preventive safety bubble can avert distress before it occurs, potentially mitigating negative spillover effects into offline life documented in prior research on social VR harassment [8]. Harassment in social virtual worlds often stems from the lack of mechanisms that allow users to grant or deny consent to virtual interactions in advance [67]. As a consent-based tool, the safety bubble enables users to explicitly approve interactions, preventing

unwanted experiences. Additionally, because perceptions of proxemic invasions are subjective and vary across individuals, customizable safety bubbles let users to define personal boundaries and control who may enter them [67]. This approach surpasses reactive, one-size-fits-all solutions that depend on a universal definition of harassment, which is difficult in virtual spaces accessed by users from diverse cultural and legal contexts.

6.4 Tradeoff between Safety Bubbles and Blocking

In practice, the comparison between safety bubbles and avatar blocking may be more nuanced and involve trade-offs. While safety bubbles are perceived as more effective than avatar blocking in our study – reflected in consistently higher ratings across categories compared to no-feature conditions – their implementation is more complex. Moreover, users must familiarize themselves with the feature and configure settings [42], which requires upfront time and effort not captured in our idealized vignettes. New users, in particular, may struggle to understand and apply safety bubble settings without prior experience, potentially limiting their virtual world experience upon entry or during harassment [30]. In contrast, avatar blocking is simpler to implement and more intuitive for users, requiring less cognitive effort. Reactive tools remain valuable as fallback, particularly for users familiar with social media [42]. Platform providers should consider these trade-offs when implementing proximity-control features. In the best-case scenario, layered safety features – combining preventive and reactive tools – can address different types of proximity invasions across varied scenarios, maximizing user protection [87].

While safety bubbles are useful, they also create a trade-off between safety and functionality [26]. If personal space protection is not balanced with functionality, the bubble becomes a gilded cage, limiting interactions and collaborations in virtual experiences [26, 30]. This can prevent actions like passing virtual objects or performing social gestures like handshakes or high-fives [26]. Such preemptive protection may also deny meaningful interactions, causing users to miss opportunities for engagement [42]. If safety overly constrains functionality, users may disable the bubble to participate more fully in social virtual worlds [26].

Moreover, a limitation of safety bubble is that it may still create a power imbalance that favors the aggressor. When a perpetrator enters the bubble, the intrusion becomes solely invisible to the victim [67]. Third party can still observe the harassment incident, potentially causing reputational or social harm to the victim. Additionally, the victim may remain aware that the harassment is ongoing, which can have traumatizing effects [67].

6.5 Methodological Contribution

Our study also contributes methodologically to research on harassment and safety features in social virtual worlds. Prior work has mainly relied on interviews [8, 15, 16, 17, 35, 37, 38], retrospective surveys [42], or analysis of post-hoc reports [25, 51], often depending on participants' recall and conflating different harassment types without accounting for varying severity. In contrast, our vignette study presents the same personal space invasion scenario across conditions with and without safety features, allowing for controlled comparisons and more reliable insights into how participants perceive and respond to harassment.

Unlike prior studies mainly focusing on existing social virtual world users, we surveyed a broader, representative sample of the population in Germany, a technologically advanced and personal-space-sensitive society [18, 63]. This responds to calls for research on social virtual worlds and related phenomena, such as the vision of realizing a 'metaverse', with diverse demographic samples to capture a wider range of perspectives [71] and to evaluate the technical and conceptual foundations of social virtual worlds for the general public [39]. Our approach also addresses prior studies' neglect of female users [39]. This strengthens the generalizability of our findings and provides a solid foundation for future research.

6.6 Limitations and Future Work

Like any study, ours has limitations and suggests directions for future research. First, we used a video vignette-based survey depicting a relatively mild personal space invasion rather than an experimental design involving a more severe invasion. While this approach avoided exposing participants to unnecessary harm, it may not fully capture authentic cognitive and emotional responses in immersive social VR, where personal space violations can feel more immediate and threatening [68]. Although our Roblox-based video stimuli allowed for controlled presentation, they differ from embodied VR experiences delivered via HMDs. Even three degrees of freedom (3DoF) immersive experiences can evoke stronger realism, spatial presence, and user involvement than 2D video observation [82, 83]. This may particularly affect perceptions of immediate bodily space. The differences are likely more pronounced in interactive six degrees of freedom (6DoF) VR simulations that provide greater agency through self-directed movement and interaction [83]. Future research should therefore conduct ethically approved VR experiments to examine safety features perceptions across a wider range of harassment scenarios, potentially incorporating bystander perspectives to minimize harm.

Second, the design of the vignette without safety features (V1) may have introduced bias, as individuals differ in their responses to harassment. Although avoidance is the most common coping strategy [76, 79], some users may have preferred confrontation [37, 80]. Prescribing avoidance in V1 constrained participants' ability to choose their own coping strategies, potentially diverging from their natural responses and biasing perceptions of the condition without safety features. This may limit the generalizability of our findings. Future research should allow participants to self-select coping strategies aligned with their personal preferences.

Third, our study was conducted in Germany, an individualistic and privacy-conscious society where people tend to be more conservative regarding proximity invasions and place strong emphasis on personal space. However, privacy and personal space norms vary across cultures [18, 62], even in avatar-mediated interactions [69]. For instance, Asian dyads have been shown to interact at greater distances than European dyads [69]. Therefore, our findings may not generalize to other cultural contexts. Future research should conduct cross-cultural studies to examine perceptions of safety features in different countries.

Fourth, we investigated only two proximity-control features – safety bubbles and avatar blocking. While these represent widely implemented preventive and reactive measures [42, 67], future studies should also explore other proximity-control features.

Fifth, using Roblox as the development environment for the vignettes may have introduced platform-specific constraints and design characteristics. Consequently, the developed vignettes may reflect styles typical of Roblox rather than other social virtual world platforms. Future research could explore different platforms to examine how platform-specific characteristics and avatars influence perceptions of harassment and safety features.

7 Conclusion

In this study, we evaluated how safety features influence key adoption-related factors of social virtual worlds. Our results highlight that proximity-control features, such as safety bubbles and avatar blocking, significantly enhance trust, controllability, satisfaction, and use intention compared to social virtual worlds without safety features. Safety bubble further improves perceived safety and reliability by proactively preventing distress, though they may involve trade-offs. Overall, integrating safety features is crucial for fostering user engagement and equitable participation.

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References

[1] H. Aguinis and K. J. Bradley. Best Practice Recommendations for Designing and Implementing Experimental Vignette Methodology Studies. *Organizational Research Methods*, 17(4):351-371, 2014.

[2] I. Ajzen. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2):179-211, 1991.

[3] C. Atzmüller and P. M. Steiner. Experimental vignette studies in survey research. *Methodology*, 6(3):128-138, 2010.

[4] G. Bansal, F. Zahedi, and D. Gefen. The role of privacy assurance mechanisms in building trust and the moderating role of privacy concern. *Eur. J. Inf. Systs.*, 24(6):624-644, 2015.

[5] D. Bar-Tal and D. Jacobson. A psychological perspective on security. *Applied Psychology: An International Review*, 47(1):59-71, 1998.

[6] T. Basu. The metaverse has a groping problem already. *MIT Technology Review*, 2021. https://www.technologyreview.com/2021/12/16/1042516/the-metaverse-has-a-groping-problem/ (Accessed July 31, 2025).

[7] J. Belamire. My First Virtual Reality Groping. *Medium*, 2016. https://medium.com/athena-talks/my-first-virtual-reality-sexual-assault-2330410b62ee#.8lcy2o2bh (Accessed July 31, 2025).

[8] L. Blackwell, N. Ellison, N. Elliott-Deflo, and R. Schwartz. Harassment in Social Virtual Reality: Challenges for Platform Governance. In *Proc. ACM HCI*, 3(CSCW, 100):1-25, 2019.

[9] C. Calvo-Porral, A. Faíña-Medín, and M. Nieto-Mengotti. Exploring technology satisfaction: An approach through the flow experience. *Computers in Human Behavior*, 66:400-408, 2017.

[10] S. Camacho, K. Hassanein, and M. Head. Cyberbullying impacts on victim's satisfaction with information and communication technologies: The role of Perceived Cyberbullying Severity. *Information & Management*, 55(4):494-507, 2018.

[11] Y. Chen, X. Luo, and H. Li. Beyond adaptive security coping behaviors: Theory and empirical evidence. *Information & Management*, 59(2):1-16, 103575, 2022.

[12] Y. Dwivedi et al. Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *Int. J. Inf. Manag.*, 66:1-55, 2022.

[13] Y. Dwivedi et al. Exploring the darkverse: A multi-perspective analysis of the negative societal impacts of the metaverse. *Inf. Syst. Front.*, 25, 2023.

[14] N. Fay, B. Walker, Y. Kashima, and A. Perfors. Socially Situated Transmission: The Bias to Transmit Negative Information is Moderated by the Social Context. *Cognitive Science*, 45(9), 2021.

[15] C. Fiani, R. Bretin, S. MacDonald, M. Khamis, and M. McGill, M. Pikachu would electrocute people who are misbehaving: Expert, Guardian and Child Perspectives on Automated Embodied Moderators for Safeguarding Children in Social Virtual Reality. In *Proc. CHI Conf. Hum. Factor Comput. Syst.*, 1-23, 113, 2024.

[16] G. Freeman, S. Zamanifard, D. Maloney, and D. Acena, D. Disturbing the Peace: Experiencing and Mitigating Emerging Harassment in Social Virtual Reality. *ACM HCI,* 6(CSCW1), 85, 2022.

[17] G. Freeman, L. Li, and K. Schulenberg, K. "I Have Abused Someone Who Abused Me": Understanding People Who Have Experienced Both Sides of Harassment Accusations in Social VR. *ACM on Human-Computer Interaction*, 9(2), CSCW107, 1-26, 2025.

[18] E. T. Hall. *The hidden dimension*. NY Doubleday, 1966.

[19] J. M. Hansen, G. Saridakis, and V. Benson. Risk, trust, and the interaction of perceived ease of use and behavioral control in predicting consumers' use of social media for transactions. *Computers in Human Behavior*, 80:197-206, 2018.

[20] H. Hecht, R. Welsch, J. Viehoff, and M. R. Longo. The shape of personal space. *Acta Psychologica*, 193, 2019.

[21] E. Hermann, M. Morgan, and J. Shanahan. Cultivation and social media: A meta-analysis. *New Media Soc.*, 25(9):2492-2511, 2023.

[22] D. L. Hoffman, T. P. Novak, and M. Peralta. Building consumer trust online. *Communications of the ACM*, 42(4):80-85, 1999.

[23] B. Holfeld. Perceptions and attributions of bystanders to cyber bullying. *Computers in Human Behavior*, 38:1-7, 2014.

[24] J. Intravia, K. Wolff, R. Paez, and B. Gibbs. Investigating the relationship between social media consumption and fear of crime: A partial analysis of mostly young adults. *Computers in Human Behavior*, 77:158-168, 2017.

[25] J. Jadamba and D. Kang. There I was, being virtually groped: Explore psychological ownership and the framing of sexual harassment in the immersive virtual reality space. *Comput. Hum. Behav,* 162:1-10, 2025.

[26] K. LaRubbio, E. Wilson, S. Koppal, S., Jörg, and E. Jain. Give me some room please! Personal space bubbles for safety and performance. *IEEE VRW*, 2023.

[27] P. B. Lowry, G. D. Moody, and S. Chatterjee. Using IT Design to Prevent Cyberbullying. *J. Manag. Inf. Syst.*, 34(3):863-901, 2017.

[28] A. Malik, S. Sinha, and S. Goel. Coping with workplace sexual harassment: Social media as an empowered outcome. *Journal of Business Research*, 150:165-178, 2022.

[29] C. Maier, S. Laumer, C. Weinert, and T. Weitzel. The effects of technostress and switching stress on discontinued use of social networking services: a study of Facebook use. *Information Systems Journal*, 25(3):275-308, 2015.

[30] V. McIntosh and C. Allen. What do policymakers need to know about harassment in the metaverse? *Front. Virtual Real.*, 5:1-8, 2024.

[31] D. H. McKnight, M. Carter, J. B. Thatcher, and P. F. Clay. Trust in a specific technology: An investigation of its components and measures. *ACM Trans. Manag. Inf. Syst.*, 2(2):1-25, 12, 2011.

[32] M. Meier. Navigating the Landscape of IT Threats: A Literature Review and the Road Ahead. In *Proc. ECIS*, 11, 2024.

[33] R. L. Oliver. Cognitive, Affective, and Attribute Bases of the Satisfaction Response. *J. Consum. Res.*, 20(3):418-430, 1993.

[34] J. Outlaw. Virtual Harassment: The Social Experience of 600+ Regular Virtual Reality (VR) Users. Virtual Reality Pop. *Medium*, 2018. https://virtualrealitypop.com/virtual-harassment-the-social-experience-of-600-regular-virtual-reality-vr-users-23b1b4ef884e (Accessed July 31, 2025).

[35] N. Sabri, B. Chen, A. Teoh, S. P. Dow, K. Vaccaro, and M. Elsherief. Challenges of Moderating Social Virtual Reality. In *Proc. CHI Conf. Hum. Factor Comput. Syst.*, 384:1-20, 2023.

[36] N. J. Sales. A girl was allegedly raped in the metaverse. Is this the beginning of a dark new future? *The Guardian*, 2024.

[37] K. Schulenberg, G. Freeman, L. Li, and C. Barwulor. Creepy Towards My Avatar Body, Creepy Towards My Body: How Women Experience and Manage Harassment Risks in Social Virtual Reality. In *Proc. ACM Hum. Comput. Interact.*, 7(CSCW2):1-29, 236, 2023.

[38] K. Schulenberg, L. Li, G. Freeman, S. Zamanifard, and N. McNeese. Towards Leveraging AI-based Moderation to Address Emergent Harassment in Social Virtual Reality. In *Proc. CHI Conf. Hum. Factor Comput. Syst.*, 1-17, 514, 2023.

[39] T. C. Peck, L. E. Sockol, and S. M. Hancok. Mind the gap: The underrepresentation of female participants and authors in virtual reality research. *IEEE TVCG*, 26(5): 1945-1954, 2020.

[40] K. Van Royen, K. Poels, H. Vandebosch and P. Adam. Thinking before posting? Reducing cyber harassment on social networking sites through a reflective message. *Comput.Hum. Behav.* 66:345-352, 2017.

[41] V. Venkatesh, M. Morris, G. Davis, and F. Davis. User acceptance of information technology: toward a unified view. *MISQ* 27(3):425-478, 2003.

[42] M. Weerasinghe et al. Beyond Mute and Block: Adoption and Effectiveness of Safety Tools in Social VR, from Ubiquitous Harassment to Social Sculpting. *IEEE TVCG* 31(5), 3275-3284, 2025.

[43] B. K. Wiederhold. Sexual Harassment in the Metaverse. *Cyberpsychol. Behav. Soc. Netw.*, 25(8):479-480, 2022.

[44] L. Wilcox, R. Allison, S. Elfassy, and C. Grelik. Personal space in virtual reality. *ACM Trans. Appl. Percept.*, 3(4):412-428, 2006.

[45] J. Williamson, J. Li, V. Vinayagamoorthy, D. Shamma, and P. Cesar. Proxemics and social interactions in an instrumented virtual reality workshop. In *Proc. CHI Conf. Hum. Factor Comput. Syst.*, 2021.

[46] J. Williamson, J. O'Hagan, J. Guerra-Gomez, J. Williamson, P. Cesar, and D. Shamma. Digital Proxemics: Designing Social and Collaborative Interaction in Virtual Environments. In *Proc. CHI Conf. Hum. Factor Comput. Syst.*, 1-12, 423, 2022.

[47] J. C. Wong. Sexual harassment in virtual reality feels all too real – "it's creepy beyond creepy" *The Guardian*, 2016.

[48] Y. Wu, F. Li, R. Triplett, and I. Sun. Media Consumption and Fear of Crime in a Large Chinese City. *Soc. Sci. Q.*, 100:2337-2350, 2019.

[49] R. Xie, J. Kirchner-Krath, and B. Morschheuser. Towards an Ethical Metaverse: A Systematic Literature Review on Privacy Challenges. *European Conference on Information Systems*, 1-16, 2024.

[50] B. Zapan, A. Wang, and H. Xu. A perceived reliability-based customer satisfaction model in self-service technology. *The Service Industries Journal*, 38(7-8):446-466, 2018.

[51] Q. Zheng et al. Understanding Safety Risks and Safety Design in Social VR Environments. In *Proc. ACM Hum. Comput. Interact.*, 7(CSCW1):1-37, 154, 2023.

[52] S. Zhou, Q. Guan, H. Yang, and Y. Cao. Navigating the social media landscape: unraveling the intricacies of safety perceptions. *Humanit. Soc. Sci. Commun.*, 11, 1420, 2024.

[53] J. E. Bodford, C. J. Bunker, and V. S. Y. Kwan. Does perceived social networking site security arise from actual and perceived physical safety? *Computers in Human Behavior*, 121, 106779, 2021.

[54] D. Rasch, K. D., Kubinger, and K. Moder. The two-sample t test: pre-testing its assumptions does not pay off. *Stat. Pap.*, 52: 219-231.

[55] U. Knief and W. Forstmeier. Violating the normality assumption may be the lesser of two evils. *Behav. Res. Methods*, 53: 2576-2590.

[56] L. Bergkvist and J. R. Rossiter. Tailor-made single-item measures of doubly concrete constructs. *Int. J. Advert.*, 28(4): 607-621, 2009.

[57] S. G. Rogelberg and J. M. Stanton. Introduction: Understanding and Dealing With Organizational Survey Nonresponse. *Organizational Research Methods*, 10(2):195-209, 2007.

[58] A. L. Drolet and D. G. Morrison. Do We Really Need Multiple-Item Measures in Service Research? *J. Serv. Res.*, 3(3): 196-204, 2001.

[59] A. Diamantopoulos, M. Sarstedt, C. Fuchs, P. Wilczynski, and S. Kaiser. Guidelines for choosing between multi-item and single-item scales for construct measurement: a predictive validity perspective. *J. Acad. Mark. Sci.*, 40, 434-449, 2012.

[60] G. Bennett, L. McNeill, K. Wolin, D. Duncan, E. Puleo, and K. Emmons. Safe To Walk? Neighborhood Safety and Physical Activity Among Public Housing Residents. *PLoS Med*, 4(10):e306, 2007.

[61] N. Zhang, C. Wang, E. Karahanna, and Y. Xu. Peer Privacy Concern: Conceptualization and Measurement. *MIS Q.*, 46(1): 491-529, 2022.

[62] M. C. Beaulieu. Intercultural Study of Personal Space: A Case Study. *Journal of Applied Social Psychology*, 34(4):794-805. 2006.

[63] R. Shuter. A field study of nonverbal communication in Germany, Italy, and the United States. *Commun. Monogr.*, 44:298-305, 1977.

[64] A. Sorokowska, et al. Preferred Interpersonal Distances: A Global Comparison. *J. Cross-Cult. Psychol.*, 48(4):577-592, 2017.

[65] J. N. Bailenson, J. Blascovich, A. C. Beall, and J. M. Loomis. Interpersonal Distance in Immersive Virtual Environments. *Personality and Social Psychology Bulletin*, 29(7): 819-833.

[66] G. W. Evans, and R. B. Howard. Personal space. *Psychological Bulletin*, 80(4): 334-344, 1973.

[67] D. Zytko, and J. Chan. The Dating Metaverse: Why We Need to Design for Consent in Social VR. IEEE Trans. Vis. Comput. Graph., 29(5), 2489-2498, 2023.

[68] V. Smekal, J. Hecquard, …, and M. Macé. Influence of Haptic Feedback on Perception of Threat and Peripersonal Space in Social VR. *IEEE Trans. Vis. Comput. Graph.*, 31(5), 2986-2994, 2025.

[69] B. S. Hasler, and D. A. Friedman. Sociocultural Conventions in Avatar-Mediated Nonverbal Communication: A Cross-Cultural Analysis of Virtual Proxemics. *Journal of Intercultural Communication Research*, 41(3), 238-259, 2012.

[70] K. Shriram, and R. Schwartz. All are welcome: Using VR ethnography to explore harassment behavior in immersive social virtual reality. *IEEE VR*, 2017.

[71] D. Maloney, G. Freeman, and A. Robb. Social Virtual Reality: Ethical Considerations and Future Directions for An Emerging Research Space. *IEEE VRW*, 2021.

[72] D. Maloney, G. Freeman, and A. Robb. It Is Complicated: Interacting with Children in Social Virtual Reality. *IEEE VRW*, 2020.

[73] J. S. N. Guthula, and A. Basu. Navigating Gender Biases in XR: Towards Equitable Technological Future. *IEEE VRW*, 2024.

[74] M. Slater et al. The Ethics of Realism in Virtual and Augmented Reality. *Front. Virtual Real.*, 1:1-13, 2020.

[75] M. Mello, L. Dupont, T. Engelen, A. Acciarino, A. W. de Borst, and B. de Gelder. The influence of body expression, group affiliation and threat proximity on interactions in virtual reality. *Current Research in Behavioral Sciences*, 3, 100075, 2022.

[76] A. C. Cote. I can defend myself: Women's strategies for coping with harassment while gaming online. *Games. Cult.*, 12(2):136-155, 2017.

[77] E. Scidone, M. J. Phillips, and A. M. Pantaleo. Hiding in the shadows: a qualitative exploration of women gamers identities and perceptions of the video gaming context. *SN Social Sciences*, 4, 181: 1-32, 2024.

[78] J. Fox, and W. Y. Tang. Women's experiences with general and sexual harassment in online video games: Rumination, organizational responsiveness, withdrawal, and coping strategies. *New Media & Society*, 19(8): 1290-1307, 2017.

[79] R. Fuchs, J. Droste, and A. Dockhorn. How Do Players Perceive Gender Discrimination? On the Differences of Harassment in Online Games. *IEEE Conference on Games*, 1-8, 2025.

[80] C. J. Passmore, and R. L. Mandryk. A Taxonomy of Coping Strategies and Discriminatory Stressors in Digital Gaming. *Frontiers in Computer Science*, 2, 40: 1-20, 2020.

[81] Roblox Corporation. Roblox units. https://create.roblox.com/docs/physics/units (Accessed Jan. 2026).

[82] F. Mathis, J. O'Hagan, M. Khamis, and K. Vaniea. Virtual Reality Observations: Using Virtual Reality to Augment Lab-Based Shoulder Surfing Research. *IEEE VR*, 2022.

[83] A. P. A. van Zelderen, T. C. Masters-Waage, N. Dries, J. I. Menges, and D. R. Sanchez. Simulating Virtual Organizations for Research: A Comparative Empirical Evaluation of Text-Based, Video, and Virtual Reality Video Vignettes. *Organ. Res. Methods*, 28(3): 457-486, 2024.

[84] N. Yee, J. N. Bailenson, M. Urbanek, F. Chang, and D. Merget. The Unbearable Likeness of Being Digital: The Persistence of Nonverbal Social Norms in Online Virtual Environments. *Cyberpsychology & Behavior*, 10(1): 115-126, 2007.

[85] J. Llobera, B. Spanlang, G. Ruffini, and M. Slater. Proxemics with multiple dynamic characters in an immersive virtual environment. *ACM Transactions on Applied Perception*, 8(1), 3:1-12, 2010.

[86] R. Xie, S. F. Chen, S. Birnstiel, and B. Morschheuser. Self-Disclosure in Metaverse-based Mental Healthcare: The Role of Avatars. *Hawaii International Conference on System Sciences*, 2957-2966, 2026.

[87] T. Hubert et al. Privacy by Design: Schutz der Privatheit im Metaverse durch Designpraktiken am Beispiel ausgewählter Gefahren für Datenschutz und Persönlichkeitsrechte. Freiheit in digitalen Infrastrukturen, Baden-Baden, Nomos, 285-318, 2025.

[88] F. Franke, R. Xie, and B. Morschheuser. User Perspectives on Law-Sensitive Design in the Metaverse: Balancing Design, Regulation, and Acceptance. Privacy, Data Protection and Digital Policy in Times of Crisis: Poster Proceedings, Karlsruhe: Fraunhofer ISI, 51-56, 2025.