

Face-off: facial expression disclosure affects the processing of proxemic norms in virtual reality

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Abstract

As virtual reality (VR) technologies support various forms of social interactions, questions have emerged regarding whether and how interpersonal proxemic norms are enacted in VR. Meanwhile, VR's body tracking features, particularly face and eye tracking, have fostered more natural and vivid communication. However, these tracking features also intensify users' pressure to manage self-image and privacy. Drawing on lab experiments, psychophysiological measures, and qualitative interpretations, this study seeks to understand how face tracking influences individuals' cognitive and affective reactions to proxemic norm violation in VR. The findings suggest that although participants perceive proxemic norm violations as improper, physiologically arousing, and unpleasant, emerging norms in VR have subtly shifted these reactions. Participants' gender and facial expression visibility separately or jointly moderate the effects of norm violation on perceived politeness, identifiability, and social presence. The potential theoretical integration of presence, transformed social interaction, and objective self-awareness is discussed to inform future research.

Lay Summary

Virtual reality (VR) technologies allow users to experience immersive environments that are not necessarily accessible in the physical world. In virtual worlds, users sometimes ignore social norms and make others feel uncomfortable by, for example, walking through others' avatars, jumping over others, or standing too close to others. Many new VR headsets now include face tracking, which may change how users respond to norm violation in VR. Face tracking renders users' facial expressions visible to others, makes users more self-aware, and increases users' pressure to manage behavior. By collecting participants' self-reported feelings and physical reactions, we found that participants perceived violating social norms in VR as inappropriate and experienced negative emotions. Additionally, men tended to hide their facial expressions after breaking social norms, whereas women tended to disclose their facial expressions to maintain their social image. We also found that new norms are gradually emerging in VR, as some participants believed that breaking personal space norms is common and acceptable in virtual environments. This study highlights the need for clearer behavioral guidelines that reflect users' shared expectations and calls for more transparency about how face tracking affects users in VR.

Virtual reality (VR) offers novel and immersive experiences that users may not otherwise access in everyday lives. For example, VR allows users to experience different body images through avatar customization, utilize superpowers such as flying to engage in prosocial behavior, and embody nonhuman entities such as sea turtles, thereby developing empathy toward them. Meanwhile, concerns regarding users' behavior in VR have also arisen, as VR may afford actions that appear socially inappropriate, undermine interpersonal comfort, and pose challenges for platform governance. Breaking proxemic norms represents one

form of such actions, as even in VR, users maintain personal space and interpersonal distances (Kim & Sung, 2024). Examples of proxemic norm violations include standing too close to others, hovering above others' avatars, or passing through others' virtual bodies.

According to prior mediated communication research, the suppression of social cues serves as one of the factors that explain users' anti-normative behavior (Kiesler et al., 1984). Given that VR users may adopt pseudonyms, mute their voices, and customize avatars to obscure their identities, norm violation has

become increasingly prevalent and difficult to regulate. However, the recent implementation of face tracking, particularly facial expression tracking (FET), in VR headsets has called for a more situated, nuanced understanding of user behavior in VR. On the one hand, FET facilitates a positive experience through simulating natural and lifelike facial expressions (Kruzic et al., 2020). On the other hand, it scans users' facial movements, reveals users' emotions, and increases users' pressure to manage their privacy and self-presentation (Xu et al., 2025).

This study examines how disclosing facial expressions through the activation of FET transforms individuals' reactions to proxemic norm violation in VR. Drawing on the approach of triangulation (Cook, 1985) to establish convergence and correspondence among users' self-reported responses in experiments, psychophysiological reactions, and qualitative interpretations, this study aims to provide a comprehensive account of individuals' cognitive and affective responses to their norm-violating behavior under the influence of FET.

This study addresses the following implications. First, it seeks to understand whether VR users transfer their psychological reactions to norm violation from non-mediated environments to mediated ones. Prior presence literature has suggested that individuals often perceive new media environments as real places (Lombard & Ditton, 1997). Situated in social VR contexts, this study tests whether individuals process norm violations as if they occurred in physical spaces.

Second, prior VR literature on face has centered on the effects of seeing others' faces or the perceived realism of face (Bonfert et al., 2023; Yee et al., 2007). Yet, how facial expression visibility in VR affects users' own cognitive and affective reactions remains largely unknown. This study draws on transformed social interaction (TSI) and extends this framework by elucidating the influence of facial expression disclosure on one's own psychophysiological responses to norm violation in VR.

Third, this study delves into how facial expression disclosure in VR interacts with users' proxemic norm transfer experience. Given that displaying facial expressions in VR may reveal users' emotional states and identities, the extent to which users leverage FET to enjoy virtual face-to-face experiences while simultaneously managing their self-presentation to protect privacy and navigate social etiquette remains unexplored. Hence, investigating the effects of disclosing facial expressions helps parse the boundaries of when and how individuals apply psychophysiological reactions to norm violation from physical to virtual environments.

Literature review

Proxemics, presence, and VR

Social norms serve as implicit or explicit rules that guide people's behavior without the force of laws (Van Kleef et al., 2015). Violating norms can trigger negative cognitive, affective, and behavioral responses. Centering on proxemics, that is, "the study of man's perception and use of space" (Hall, 1968, p. 83), past work has suggested that pedestrians whose personal space was invaded while waiting at a crosswalk experienced negative emotions and that they were less willing to offer help to the

intruders (Smith & Knowles, 1978). Efran and Cheyne (1974) found that participants asked to trespass the shared space of two communication partners reported negative moods such as feeling embarrassed and unpleasant. Norm violation has been found to induce not only anger, anxiety, and fear in others, but also guilt, shame, and disappointment in transgressors themselves (Van Kleef et al., 2015).

Beyond the physical world, research has examined how individuals process proxemic norms in virtual and augmented reality (AR) environments. Researchers found that participants maintained a comfortable personal space during conversations in VR and reacted with discomfort when their space was invaded (Jeffrey & Mark, 2003). Bailenson et al. (2001) found that compared to a virtual cylinder, users were more likely to avoid contact with a humanlike agent and gave the agent more space. Compliance with proxemic norms was also observed in AR environments: When an AR headset layered a virtual agent on a physical chair, participants avoided sitting there, treating the space as if it had been occupied (Miller et al., 2019).

The transfer of interpersonal proxemic norms to VR occurs partly due to presence, a psychological experience that drives the application of real-world social rules to virtual environments and actors. Defined as the "perceptual illusion of non-mediation" (Lombard & Ditton, 1997), presence has been used to conceptualize how individuals perceive virtual humans and places as if they were real. Presence has been broadly categorized into three types: spatial presence, social presence, and self-presence. Spatial presence focuses on the sense of being there (Biocca, 1997), whereas social presence refers to the sense of being with another (Biocca et al., 2003), or more recently, the "perceptual salience of another social actor" (Cumplings & Wertz, 2023, p. 1). Self-presence is the psychological state in which individuals experience virtual selves as actual selves (Lee, 2004a).

Presence occurs partly because the instinct to treat incoming information and potential threats as real is imprinted in human evolution as a survival mechanism (Lee, 2004b). This perspective was also elaborated in research on individuals' social responses to media: "what is part of non-mediated reality and what is pictorial representation must be treated as equivalent because the cost of confusing a real threat with a symbolic representation of a real threat is too great" (Lombard, 1995, p. 290).

Ample research has demonstrated that experiencing presence via immersive media elicits emotional reactions that mirror real-life experiences of arousal and valence. Fox and colleagues (2012) found that participants experienced high physiological arousal when seeing their virtual selves running in VR, as they felt as if they were engaged in the running exercises. Han et al. (2023) placed participants in 192 different virtual spaces and found that being in a spacious, panoramic, and outdoor environment evoked more pleasure, restorativeness, and spatial presence, whereas being in a constrained environment created feelings of stress and confinement, which dovetails with individuals' experiences in real spaces.

Despite research on users' application of interpersonal proxemic norms in VR, some findings point to different directions. In Hackney et al.'s (2020) study, participants were asked to walk through a virtual aperture created by two virtual poles or two avatars. As indicated by shoulder rotation angles and walking

velocity, participants did not act more cautiously when passing between the avatars than between the virtual poles. Kim and Sung (2024) found that although interpersonal distances in VR decreased as users became familiar with each other, the distances remained larger than those observed in real spaces.

Given the mixed findings on users' transfer of proxemic norms from interpersonal communication to VR, new evidence would benefit from examining the consequences of norm violation, as in the physical world the effects of norms become most salient when they are breached, which can trigger individuals' negative cognitive and affective reactions even in the transgressors themselves (Efran & Cheyne, 1974; Van Kleef et al., 2015). Thus, if users carry real-world social rules to virtual spaces, breaking these rules should evoke negative emotions like guilt and shame. Accordingly, we propose the following hypotheses.

H1: Compared to norm compliance, violation of proxemic norms in VR will lead users to perceive their behavior as less polite.

H2: Compared to norm compliance, violation of proxemic norms in VR will elicit more negative emotional reactions, less pleasure, and greater physiological arousal.

Facial Expression Tracking (FET) in VR

Recent VR headsets have been equipped with multiple tracking features to enhance presence experiences. Hand tracking, head tracking, body motion tracking, FET, and eye tracking provide users with real-time proprioceptive, vestibular, and visuomotor feedback (Xu et al., 2025). A recent review of 30 years of psychological experimentation in VR positioned body tracking as one of the features that render VR experiences unique (Bailenson et al., 2025). A meta-analysis of the effects of technological immersion also suggested that tracking level has a greater influence on presence than other immersive features (Cummings & Bailenson, 2016).

Compared to other tracking features (Herrera et al., 2020), research on the effects of face tracking is still in its infancy. Prior VR research on face has primarily followed two threads. One thread has investigated the effects of seeing others' faces in mediated environments. For example, Bonfert et al. (2023) found that compared to video calls, not being able to see others' real faces in VR was considered disconcerting and awkward, which undermined users' social presence. Kruzic et al. (2020) found that seeing other avatars' facial expressions had more weight than seeing body motion in affecting interpersonal attraction, affective states, and impression accuracy. The other thread has centered on the perceived realism of virtual faces. A meta-analysis suggested that virtual faces with higher behavioral and photographic realism produce more positive social interactions than those with lower realism (Yee et al., 2007).

Despite these two lines of research, how FET in VR affects users' own perceptions, attitudes, and behavior remain understudied. Yet, scholars have highlighted the necessity to examine these effects. First, facial expressions reflect one's mental states like engagement and pleasure (Tarnec et al., 2023), which foster a strong sense of immersion in VR. Second, displaying one's own facial expressions raises users' social and privacy concerns, as

users may feel mentally onerous to manage their images in VR (Xu et al., 2025).

Displaying facial expressions in VR, then, can have opposing effects. While it elevates users' social presence, pleasure, and interpersonal closeness, it also aggravates concerns about revealing emotional states and privacy. It is here where TSI can serve as a guiding framework in understanding the effects of showing one's facial expressions in VR. TSI suggests that VR systems can amplify, filter, or suppress social cues to reshape social interaction (Han & Bailenson, 2024). Specifically, VR systems can transform situational contexts, sensory capabilities, and self-representation. At the level of self-representation, users can navigate VR configurations to decouple their actual nonverbal cues from rendered ones, which will impact their interaction behavior (Bailenson et al., 2004).

In our study, when users' appearances and voices are decoupled from their avatars and when only face tracking is enabled, facial expressions begin to serve as direct signals of their internal states. The visibility of facial expressions might undermine users' anonymity and raise their sensitivity to identity disclosure, which could further usher in behavior regulation. Conversely, when facial expressions are blocked alongside the suppression of the appearance and vocal cues, the cues-filtered-out effect (Culnan & Markus, 1987) might lead users to feel less identifiable and more secure about privacy. Therefore, based on TSI and the reviewed literature, we propose the following hypothesis.

H3: Compared to non-disclosure, users' disclosure of facial expressions in VR will lead to greater levels of identifiability, social presence, and perceived privacy intrusion.

To further explore how FET moderates the relationships between proxemic norm violation and one's cognitive and affective responses, this study integrates explanations from the theory of objective self-awareness, which suggests that when individuals are aware of others' observation or evaluation of them, the self becomes the focus of attention (Wicklund & Duval, 1971). Such self-focused attention further elicits self-evaluation (Wicklund, 1975). When self-aware individuals perceive discrepancies between their behavior and desired social standards, they alter their behavior to conform to the social standards (Carver, 1975).

Past research has demonstrated the cognitive, behavioral, and affective effects of objective self-awareness. Duval and Wicklund (1973) manipulated objective self-awareness by asking participants to either sit in front of a mirror and listen to their own voices or sit by a mirror and listen to others' voices. Participants with high self-awareness demonstrated less transgressive behavior than those with low self-awareness. Phillips and Silvia (2005) found that high self-awareness predicted dejection, agitation, and negative affect. Because objective self-awareness prompts individuals to compare between their behavior with social standards, negative affect may escalate when their behavior falls short of those standards (Wicklund, 1975).

Objective self-awareness has been categorized into public self-awareness and private self-awareness (Yao & Flanagan, 2006). The former motivates individuals to follow social norms, seek others' acceptance, and create a favorable public image, whereas the latter propels individuals to be different and authentic (Wiekens & Stapel, 2010). In our study, enabling FET in

VR may render users' facial expressions visible to the public and hence augment their public self-awareness, which further triggers users' self-evaluation of their behavior. Conversely, disabling FET may facilitate anonymity and introduce deindividuation effects (Diener, 1979). Under this condition, users' self-awareness in VR may diminish, potentially loosening self-regulation, increasing disinhibited behavior, and rendering communication more impersonal (Kiesler et al., 1984).

Through the lenses of objective self-awareness and deindividuation effects, the impact of FET may be more nuanced and less straightforward. As objective self-awareness may foster normative attitudes and behavior, proxemic norm violation may lead those whose facial expressions are tracked by VR devices to evaluate their actions as more impolite and noticeable, and hence to experience less social presence due to increased self-focused attention, greater guilt, and stronger physiological arousal. By contrast, due to deindividuation effects, proxemic norm violation in VR may lead those whose facial expressions are invisible to others to perceive their actions as more acceptable and less identifiable, and hence to experience stronger social presence due to increased attention to other users (Biocca et al., 2003), less guilt, and weaker physiological arousal. Therefore, we propose the following hypotheses.

H4: Compared to norm compliance, proxemic norm violation will lead users whose facial expressions are tracked in VR to report less perceived politeness of their behavior, more identifiability, more privacy intrusion, and weaker social presence; comparatively, norm violation will lead users whose facial expressions are blocked in VR to report more perceived politeness of their behavior, less identifiability, less privacy intrusion, and stronger social presence.

H5: Compared to norm compliance, proxemic norm violation will lead users whose facial expressions are tracked in VR to experience more negative emotions, less pleasure, and stronger physiological arousal; comparatively, norm violation will lead users whose facial expressions are blocked in VR to experience less negative emotions, more pleasure, and weaker physiological arousal.

Prior literature has also found gender differences in perceiving proxemic norm violation and forming objective self-awareness. Fisher and Byrne (1975) found that men reported more negative emotions when an invader sat across them, while women reported more negative emotions when the invader sat adjacent to them. Bailenson et al. (2003) noticed that women maintained greater personal space from avatars than agents in VR, whereas men did not report such differences. A meta-analysis suggested that women tend to exhibit higher self-awareness than men (Else-Quest et al., 2012). Women also demonstrated greater self-focused attention than men (Ingram et al., 1988). Given these gender differences, we propose the following questions.

RQ1: How will users' gender, disclosure of facial expressions, and proxemic norm violation interact with each other in predicting perceived politeness, identifiability, social presence, and perceived privacy intrusion?

RQ2: How will users' gender, disclosure of facial expressions, and proxemic norm violation interact with each other in predicting emotional reactions, feelings of pleasure, and physiological arousal?

Beyond the quantitative measures that capture the magnitude of individuals' reactions in VR, we further draw on qualitative inquiry to gain a fuller understanding of participants' attitudes toward facial expression disclosure and norm violation in VR. We propose the following research questions.

RQ3: What are users' attitudes toward showing facial expressions in VR?

RQ4: How do users evaluate privacy risks when showing facial expressions in VR?

RQ5: How do users evaluate norm-violating behavior in VR?

Methods

Participants

A total of 84 participants from a large public university on the east coast of the United States participated in a lab experiment. Power analysis suggested that 48 participants for a three-way mixed ANOVA would reach a required sample size ($\alpha = .05$, $\beta = .2$). Participants were told that they would help test users' navigation experience in various VR spaces. They received a \$35 gift card for compensation. After five invalid cases were removed due to technical failure, a total of 79 participants, including 48 women, 30 men, and one participant who self-identified as non-binary, were included in the analyses. They ranged from 18 to 36 years old ($M = 21.62$, $SD = 3.80$).

Experimental settings

The experiment was conducted in a lab suite where participants completed online questionnaires in one of the rooms and participated in the experiment in a connecting room (Figure 1). Experimenters used one monitor to cast participants' real-time VR experience and gave instructions at different stages of the experiment. They also used a laptop to record participants' galvanic skin responses (GSR). Participants were given a Meta Quest Pro head-mounted display (HMD) and two controllers. Quest Pro was equipped with five infrared eye and face tracking sensors, which can capture and analyze users' eye movements and facial movements.

GSR were collected with a Shimmer3 GSR+ unit. The unit has two channels of electrodermal resistance measurement. The frequency of electrodermal data collection was set at 5Hz for tonic electrodermal activities. Sensors were attached to participants' fingers, as fingers have a high density of eccrine sweat glands.

Research design and procedures

The experiment applied a 2 (facial expression disclosure: yes vs. no; between-subjects) $\times$ 2 (proxemic norm: violation vs. compliance; within-subjects) mixed factorial design. While analyzing



Figure 1 Lab experiment setting.

physiological data can benefit from a within-subjects design across all four conditions, we factored in the potential testing effect, maturation effect, and the likelihood that participants might become aware of the study purposes. Based on these considerations, we exposed participants to both proxemic norm conditions ($n = 79$) and randomly assigned them to either facial expression disclosure ($n = 40$) or non-facial expression disclosure conditions ($n = 39$), with the order of norm conditions randomized to avoid sequencing effects.

After signing the consent form, participants first completed a pre-test questionnaire about demographic information and past VR experience. Then they were led to the experiment room and instructed to wear the HMD and use the controllers. They were then placed in *Horizon Central*, one of Meta's virtual social spaces that allows users to embody in avatars and host social activities.

Participants were asked to turn on a virtual mirror to view their own avatars. To minimize confounding effects, participants were assigned the same default avatar, which was designed to be gender- and race-neutral. The avatar wore a gray T-shirt, blue pants, and a pair of white sneakers, with its skin color set to default gray. The avatar's name consisted of a random combination of letters and numbers (e.g., 3219A) to prevent participants from identifying with the avatar. Using the same pre-determined avatar could minimize the potential interaction effect between projecting users' facial expressions to the avatar and users' identification with the avatar's appearance or name cues, which could exert internal threats to the experimental manipulation (i.e., the effects of FET might be stronger on those who identified with the avatar's appearance or name).

When facing the virtual mirror, participants were instructed to raise and wave their right hands, followed by their left hands. Participants also moved their heads to see their avatars mirror the same movements. These steps were designed to let participants sense the body ownership of their avatars (see [Hartbrich et al., 2023](#)). Then, participants were asked to move freely in

Horizon Central for about 2 min. This step familiarized participants with the controllers and the virtual space.

Then, participants were asked to take off their HMD and complete two questions about the degree to which they believed that the appearances of their avatars were unrecognizable as their real selves and visually different from themselves. These questions sought to confirm that participants did not form identification with their avatars' appearances, which could ensure the manipulation of facial expression disclosure later in the experiment.

Next, the experimenters attached GSR sensors to participants' ring and pinky fingers of their non-dominant hands. They were asked to keep the two fingers in contact with the controllers and reduce their non-dominant-hand movements. The ring and pinky fingers were selected because participants needed their index and middle fingers to use the controllers.

Participants were then led to *Horizon Central* again and asked to turn on the virtual mirror. Drawing on [Hartbrich et al.'s \(2023\)](#) approach, participants were instructed to present six types of facial expressions: anger, disgust, happiness, fear, sadness, and surprise. In the *facial expression disclosure conditions*, the headset's FET and eye tracking were activated, allowing participants to see their avatars mirror all their facial expressions. Participants were also informed that their facial expressions were visible to other users in the virtual spaces. In the *non-facial expression disclosure conditions*, the headset's FET and eye tracking were deactivated. Hence, their avatars did not mirror participants' facial expressions. Participants were also informed that their facial expressions were invisible to others.

Afterward, participants were asked to take deep breaths for about 30 s, which allowed for the stabilization of GSR signals and the collection of baseline skin conductance levels (SCL). Collecting the baseline data could help determine the actual electrodermal activity change during participants' exposure to stimuli ([Potter & Bolls, 2012](#)). Then, participants were instructed to move in the space and approach a food truck in *Horizon*

Central. In front of the food truck, two VR users controlled by confederates were facing each other and chatting. The confederates were trained to remain engaged in conversations and not react to participants' behavior to standardize the procedures.

In the *norm violation conditions*, participants were asked to directly walk through the space between the two confederates. Once participants walked through them, to reinforce the manipulation, participants were asked to turn around and walk through them again. Next, participants were led to another virtual space, *VR Classroom*, which contained several enclosed spaces where users can interact with each other between the front-row desks and the rostrums. Participants were asked to enter one of the classrooms, walk through the spaces among

these users, turn around, and exit the classroom by walking through the same groups of users again.

In the *norm compliance conditions*, participants were asked to approach the two confederates near the food truck in *Horizon Central* and to walk around them. Like the behavioral violation conditions, after walking around the two confederates, they were asked to turn back and walk around the same dyad again. In *VR Classroom*, participants were asked to use the empty back-space of the classrooms to walk around other VR users between the front-row desks and the rostrums. Then they exited the classroom along the same route (Figure 2).

Both *Horizon Central* and *VR Classroom* were selected for three reasons. First, they were both public spaces where other

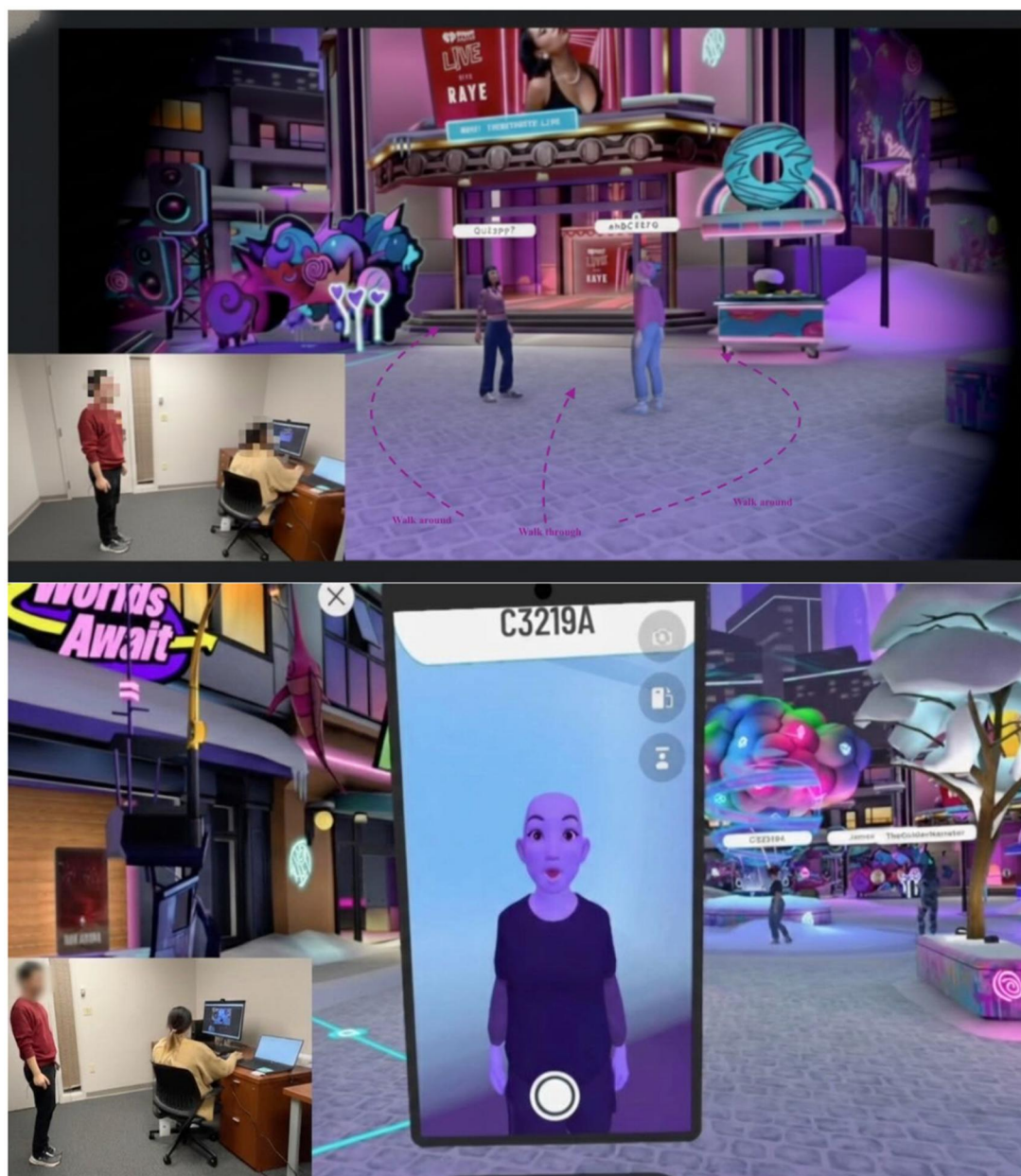


Figure 2 Crossing through/around confederates in *Horizon Central*. Dotted lines demonstrate how participants walked through/around the two confederates in *Horizon Central*. The bottom image illustrates a user displaying a surprised face in front of a virtual mirror. Minor color discrepancies exist between screen casting and participants' actual headset viewing experience. Gemini was used to anonymize the user and add the dotted lines.

Table 1 Measures.

Dependent variables	Nature of scale	<i>M</i> (<i>SD</i>)	α	<i>M</i> (<i>SD</i>)	α	Sample scale items
		Norm violation		Norm compliance		
Perceived politeness (TREES & Manusov, 1998; Van Kleef et al., 2011)	7-point Likert-type	3.94 (1.78)	.93	5.78 (1.44)	.93	My behavior was appropriate in VR. My behavior was polite in VR.
Identifiability (Hooi & Cho, 2014)	5-point Likert-type	3.36 (1.08)	.79	3.30 (1.13)	.84	My identity was indistinguishable from others in virtual environments. I blended in with other people in virtual environments.
Social presence (Lombard et al., 2009)	7-point Likert-type	4.73 (1.40)	.82	4.79 (1.35)	.84	To what extent did you have the sensation that other users could also see you in virtual environments? How much did it seem as if other users could talk directly to you?
Privacy intrusion (Choi & Kim, 2024)	7-point Likert-type	2.40 (1.42)	.90	2.56 (1.54)	.93	I believe my personal information would be more readily available to others than I would want. I feel information about me would be out there and would invade my privacy.
Negative affect scale (Watson et al., 1988)	5-point Likert-type	1.52 (.77)	.90	1.22 (.37)	.78	When you walked around/through other groups of users in VR spaces, to what extent did you experience the following feelings: scared; afraid; upset; distressed; nervous; ashamed; guilty
Pleasure (Bradley & Lang, 1994)	Self-assessment manikin (SAM)	2.83 (.90)	–	2.39 (.82)	–	Happy  Unhappy
Arousal (Bradley & Lang, 1994)	SAM	3.44 (1.15)	–	3.83 (1.05)	–	Excited  Calm
Skin conductance levels (SCL)	Electrodermal activities (GSR)	.05 μ S (.62)	–	–.12 μ S (.49)	–	SCLs were collected by recording participants' tonic electrodermal activities. Mean values were calculated for two periods: the 30-second baseline period before the stimulus exposure and the period during stimulus exposure. Final scores were calculated by subtracting the mean values of SCLs during the baseline period from those during the stimulus exposure period.

$\eta^2 = .09$. When facial expressions were disclosed, norm violation led to higher identifiability than norm compliance, whereas when facial expressions were blocked, norm compliance led to higher identifiability than norm violation (Figure 4). Norm violation and disclosure of facial expressions had no interaction effects on perceived politeness, social presence, perceived privacy intrusion, emotional reactions, feelings of pleasure, or physiological arousal. Thus, $H4$ was partially supported. $H5$ was rejected.

To examine $RQ1$, norm violation, facial expression disclosure, and gender had a three-way interaction effect on perceived

politeness, $F(1, 74) = 4.96$, $p = .029$, partial $\eta^2 = .06$. Specifically, for male participants, compared to non-disclosure, disclosure of facial expressions slightly enhanced the perceived politeness of norm compliance but lowered the perceived politeness of norm violation. Conversely, for female participants, compared to non-disclosure of facial expressions, disclosure slightly increased the perceived politeness of norm violation but weakened the perceived politeness of norm compliance (see Figure 5). Simple effects analyses revealed that for both genders, norm compliance had statistically stronger effects on perceived politeness than norm violation across different facial expression

conditions. Yet, simple effects of facial expression disclosure were not statistically significant (for details, see [Supplementary Material](#)).

Norm violation and gender had an interaction effect on social presence, $F(1, 74) = 5.36$, $p = .023$, partial $\eta^2 = .07$. For men, norm compliance led to greater social presence than norm violation, whereas for women, norm violation led to greater social presence than norm compliance ([Figure 6](#)).

Results further revealed a marginal three-way interaction effect among proxemic norm violation, facial expression disclosure, and gender on privacy intrusion, $F(1, 74) = 3.22$, $p = .077$, partial $\eta^2 = .04$. For male participants, when facial expressions were disclosed, norm violation evoked slightly more perceived privacy intrusion than norm compliance, whereas when facial expressions were blocked, norm compliance evoked slightly more perceived privacy intrusion than norm violation. By contrast, for female participants, when facial expressions were disclosed, norm compliance evoked more perceived privacy intrusion than norm violation, whereas when facial expressions were blocked, norm violation evoked slightly more perceived privacy intrusion than norm compliance ([Figure 7](#)). Simple effects analyses suggested that among female participants, when facial expressions were disclosed, norm compliance ($M = 2.65$, $SE = .30$) led to statistically higher perceived privacy intrusion than norm violation ($M = 2.12$, $SE = .27$), $p = .005$.

To answer RQ2, gender, facial expression disclosure, and proxemic norm violation did not interact with each other in predicting

emotional reactions, pleasure, or physiological arousal. Results are presented in [Tables 2](#) and [3](#). Additional analyses are presented in [Supplementary Material](#): <https://osf.io/wnt73>.

Qualitative results

Attitudes toward facial expressions

RQ3 asked about participants' attitudes toward showing facial expressions in VR. Overall, their responses suggested that showing facial expressions made their VR experience more immersive and interactive. However, participants raised concerns about the social pressure to manage their facial expressions.

Most participants mentioned that FET made their experience feel natural and realistic. Facial expressions allowed for "more context in conversations and actions" (P22), revealed "whether someone is genuine or not" (P6), and facilitated "better communication and interaction with other players, bringing fun moments to life and creating vivid memories" (P54).

Despite the immersive experience, participants emphasized that the usage of FET is context-dependent and associated with the pressure of impression management:

In reality, we sometimes need to control our facial emotions (e.g., I am not feeling like to smile but try to do that only because I do not want to be rude). At least in the virtual reality, I don't want to concern about it and [want to] feel free to walk around and talk to people without other

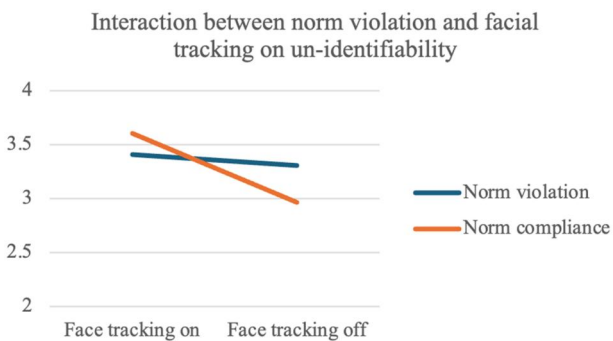


Figure 4 Interaction effects between norm violation and facial expression disclosure on un-identifiability.

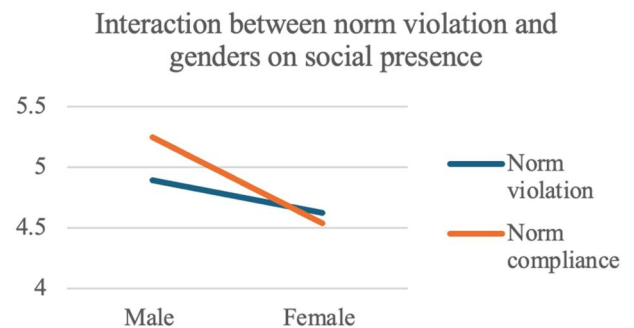


Figure 6 Interaction effects between norm violation and gender on social presence.

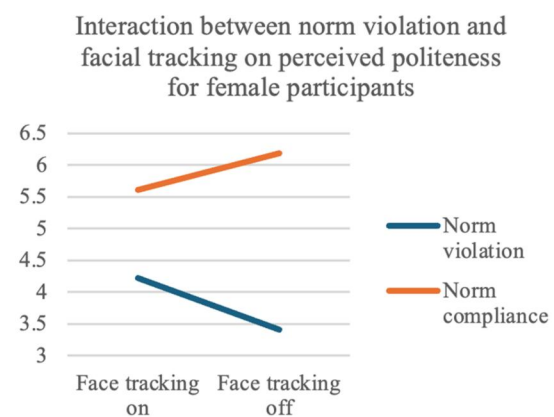
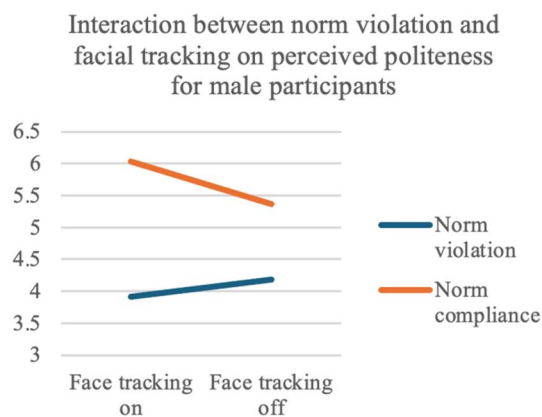


Figure 5 Three-way interaction effects on politeness.

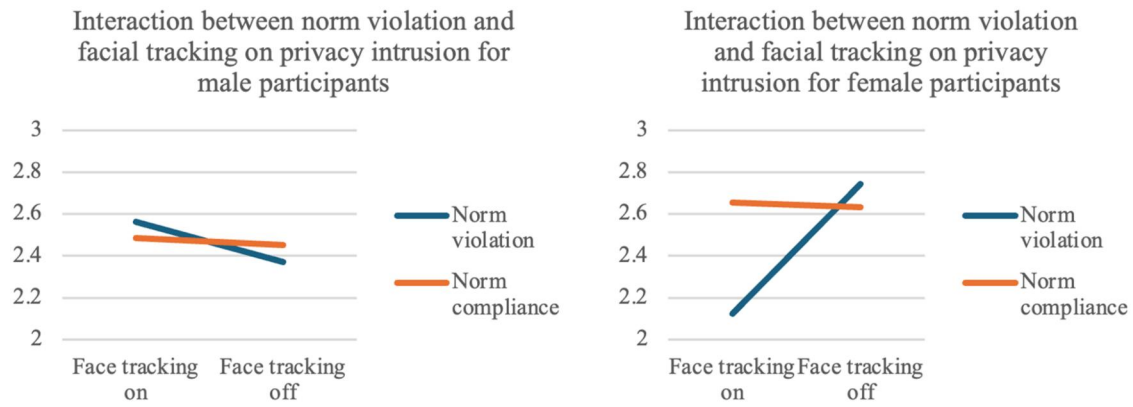


Figure 7 Three-way interaction effects on privacy intrusion.

Table 2 Three-way interaction effects on cognitive dimensions.

	Perceived politeness		Un-identifiability		Privacy intrusion		Social presence	
	<i>F</i>	η_p^2	<i>F</i>	η_p^2	<i>F</i>	η_p^2	<i>F</i>	η_p^2
Within-subjects effects								
Norm violation	52.10***	.41	.48	.01	.90	.01	1.99	.03
Norm violation × FED	.22	.00	7.07*	.09	1.20	.02	.77	.01
Norm violation × genders	.70	.01	.00	.00	.89	.01	5.36*	.07
Norm violation × FED × genders	4.96*	.06	.00	.00	3.22†	.04	.01	.00
Between-subjects effects								
FED	.31	.00	2.56	.03	.08	.00	.19	.00
Genders	.00	.00	.16	.00	.05	.00	2.48	.03
FED × genders	.02	.00	3.20†	.04	.39	.01	.05	.00

Note. η_p^2 = partial eta squared; FED = facial expression disclosure.

*** $p < .001$. * $p < .05$. † $p < .10$.

Table 3 Three-way interaction effects on affective dimensions.

	SAM-pleasure		SAM-arousal		Negative emotions		Physiological arousal	
	<i>F</i>	η_p^2	<i>F</i>	η_p^2	<i>F</i>	η_p^2	<i>F</i>	η_p^2
Within-subjects effects								
Norm violation	15.22***	.17	4.49*	.06	18.10***	.20	4.65*	.06
Norm violation × FED	.25	.00	.58	.01	.13	.00	.02	.00
Norm violation × genders	.11	.00	.44	.01	.00	.00	1.57	.02
Norm violation × FED × genders	1.47	.02	.48	.01	.08	.00	.81	.01
Between-subjects effects								
FED	.25	.00	.14	.00	1.78	.02	1.45	.02
Genders	1.13	.02	2.27	.03	1.50	.02	.07	.00
FED × genders	1.20	.02	.89	.01	.32	.00	.83	.01

Note. η_p^2 = partial eta squared; FED = facial expression disclosure.

*** $p < .001$. * $p < .05$.

catching my emotion. [...] It could be nice if the facial recognition could be on and off depending on my mood of the day. (P33)

Similarly, another participant remarked, “I didn’t like [facial expressions in VR] because if anything startled me, it could be seen by other people; I just felt like I had to watch out for my expressions” (P55). Echoing the context-dependent needs of disclosing facial expressions, one participant suggested:

If I was in the VR environment with friends, I think showing my facial expressions would be a cool addition because it would feel more personal [...]. However, I think being in a VR environment with strangers, it may be too personal and too realistic, which unsettles me a little. (P72).

Privacy concerns of facial expression recognition

Participants were also asked about their perceived privacy risks of showing facial expressions in VR (RQ4). Overall, their concerns were limited, as they regarded facial expressions as a self-expression channel. Participants explained that they were already desensitized to privacy intrusion and the level of personal data leakage through facial tracking was limited, whereas those who expressed fears for privacy intrusion mentioned the risks of personal information collection and the burden of managing self-image.

Most participants felt that the benefit of having facial expressions outweighed privacy risks. One participant preferred to show facial expressions as it mimicked real-world interactions, “The people I interact with will know my react[sic] in real-time in the virtual space and react accordingly. I don’t have to verbally express my feeling to others in the virtual world” (P2).

Participants’ privacy concerns were limited also because they were desensitized to privacy invasion. One participant mentioned that face information is already available on social media regardless of VR use. Similarly, other participants mentioned that technologies like Face ID are pervasive and “facial expressions and eye movements could already be tracked by our phones” (P68).

Moreover, some participants believed that facial tracking would not release much personal information. One participant remarked that there was no privacy risk “as long as I am not using my real-world bio information in the game, such as my appearance, my body shape, my fingerprints [...]” (P34).

Although most participants did not express privacy concerns, some participants shared their fears along the dimensions of data transfer and data analytics. One participant believed that the collection of personal data allows for privacy exploitation by technology corporates. Similarly, another participant noted that “manufacturers may collect facial recognition data and distribute it” and he did not know “why it is being distributed or to whom” (P80).

Some other participants highlighted their worries for further data analytics: “The algorithms may analyze the correlation between my facial expressions and behavioral patterns and see through me” (P42). Another commented that facial and eye scans can create access to personal accounts and she did not feel comfortable with VR devices collecting such data.

Privacy invasion was also related to the exposure that participants did not necessarily desire. Some felt that facial expressions and eye movements were revealing, as they were afraid of making “a socially wrong expression” (P60). One added, “my emotions and where I look reflects my subconscious mind and I don’t particularly want people to have access to that” (P38).

Norm violation in VR

Participants were further asked about their attitudes toward norm violation vs. norm compliance in VR (RQ5). Their responses appeared to be mixed. Specifically, those who did not treat walking through the spaces among other users as a form of violation perceived VR as same as other digital games. Multiple participants mentioned that in non-VR games (e.g., *Ponytown*, *Club Penguin*, *Minecraft*), walking through other people was considered normal. One participant commented that VR is not actual reality, “So you can do whatever you want for the most part” (P8). The absence of physical contact led participants to believe that walking through others is acceptable: “Since there will be no physical harm to users, I don’t feel moral pressure to walk through or around” (P41).

By contrast, about half of the participants mentioned that real-world norms should be transferred to virtual worlds. One commented, “If we are used to walking through people in the VR environment, we might be ignorant to others in the real life” (P34). Some other participants who preferred not to violate norms in VR mentioned the effects of avatars. “If the avatar is an extension of me, it should replicate my real-life behavior as well. As a socially polite person, I do not like the unease and discomfort I felt when walking through other users” (P44).

Discussion

Combining self-reported and physiological measures, our findings suggest that participants regarded proxemic norm violation as improper in VR spaces. Proxemic norm violation in VR evoked more negative emotional reactions and greater physiological arousal than norm compliance. Moreover, the effects of norm violation on users’ perceptions of identifiability and privacy risks were contingent upon users’ facial expression visibility and gender. This study also parses participants’ qualitative responses and discovers that facial expression disclosure not only enhanced users’ interaction experiences in VR but also elevated their pressure to manage self-image. Participants reported mixed feelings toward adhering to interpersonal etiquette in VR.

The findings first suggested that participants perceived proxemic norm violation in VR as impolite. Norm violation in VR also evoked more guilt, shame, and distress, as well as more intense physiological arousal than norm compliance. The findings corroborated prior evidence that individuals transfer psychological processing of proxemic norms from non-mediated spaces to mediated ones (Bailenson et al., 2003; Miller et al., 2019). The physiological arousal measured via electrodermal activities further suggested that users transferred not only cognitive reactions but also affective reactions from physical to virtual worlds, consistent with the present literature documenting the physiological effects of exposure to immersive media (Fox et al., 2012). Some participants’ qualitative responses aligned with these

findings. They believed that violating proxemic norms in VR could even shape their offline behavior and that their avatars should reflect their real-life manners and integrity.

Further investigation revealed a more nuanced impact of proxemic norm violation on perceived politeness, evidenced by a three-way interaction among norm violation, facial expression visibility, and gender. Although simple effects analyses suggested that norm compliance was considered more polite in VR across genders and different facial expression conditions, the three-way interaction suggested that the relationship between facial expression disclosure and evaluations of norm violation differed by gender: When men complied with proxemic norms, they perceived disclosure of facial expressions as slightly more polite than non-disclosure, whereas when they violated norms, they perceived non-disclosure of facial expressions as slightly more proper. However, when women complied with proxemic norms in VR, non-disclosure of facial expressions was perceived as slightly more polite, whereas when they violated norms, disclosure of facial expressions was considered slightly more polite.

Past research on face and facework may explain the results. Building on Goffman's (1967) work, Brown and Levinson (1987) conceptualized face as the public self-image that individuals seek to maintain during social interactions. Because violating norms may be construed as a face-threatening act, it motivates individuals to apply facework to manage their self-image. Facework refers to the strategies people use to meet their own or others' face needs (Goffman, 1967). Specifically, preventive facework involves hiding or concealing one's face to avoid possible negative consequences related to one's image, whereas restorative facework refers to actions intended to repair damaged face to reestablish one's image (Ting-Toomey & Kurogi, 1998). Because VR users can decide whether FET is activated, FET becomes a practical tool for users' facework management. Our findings suggested that men tended to engage more in preventive facework when violating proxemic norms in VR, whereas women relied more on restorative facework to repair face. In other words, men might have considered blocking facial expressions as a strategy to save face, whereas women might have treated the visibility of facial expressions as an opportunity to reduce the negative impact of face-threatening acts in VR environments.

The results also enrich the theory of objective self-awareness. The findings imply that FET might have evoked more public self-awareness among men, compelling them to maintain a favorable public image based on interpersonal proxemic norms, whereas FET might have triggered more private self-awareness among women, encouraging them to be more authentic and affirming of individualistic standards (Wiekens & Stapel, 2010). However, considering that this study did not directly measure self-awareness, future research should examine how gender and self-awareness interact in predicting the cognitive and affective outcomes of norm violation in VR.

Further, facial expression disclosure and norm violation imposed an interaction effect on perceived identifiability. Participants felt more identifiable when their facial expressions were tracked during norm violation than during norm compliance. More interestingly, when FET was disabled, participants' norm compliance led to more perceived identifiability than norm violation. The finding may be attributed to the increasing normalization of using anonymized avatars for free navigation in various digital spaces. Participants' open-ended responses supported this

explanation, as some mentioned that crossing through the shared spaces among other avatars is widely accepted in games like Minecraft. In anonymous virtual environments, strict adherence to interpersonal proxemic norms (e.g., walking around others) might be regarded as suspicious and even disturbing. The findings here implied that although users still experience physiological arousal and negative emotions when violating interpersonal norms in VR, some novel proxemic rules may be gradually taking shape in VR, and it is becoming increasingly odd not to cross others' shared spaces when social VR affords free navigation without actual physical collision. The findings may segue into the framework of TSI, which indicates that the suppression of social cues can reshape interaction behavior in VR spaces. In our study, the absence of physical touch, the deactivation of face tracking, and the decoupling of users' appearances from users' avatars might have attenuated users' self-awareness, and, to some degree, encouraged norm-violating behavior. This is congruent with the cues-filtered-out perspective (Culnan & Markus, 1987; Kiesler et al., 1984), which posits that greater anonymity may render online behavior less socially oriented and more disinhibited.

We also found that social presence served as a product of the interaction between users' gender and norm violation. For male participants, norm compliance led to greater social presence than norm violation, whereas for female participants, norm violation led to greater social presence than norm compliance. This might be because male participants believed that following proxemic norms would help save their face, thereby leading to a more positive social experience, whereas female participants might have viewed adapting to new proxemic norms as more socially engaging and interactive.

Regarding perceived privacy risks, only a marginal three-way interaction effect was found among the disclosure of facial expressions, norm violation, and gender. The small marginal effect on privacy may be explained by participants' open-ended responses, as most participants reported limited privacy risks, consistent with the average privacy intrusion score being below the scale midpoint ($M_{\text{violation}} = 2.40$; $M_{\text{compliance}} = 2.56$). Qualitative responses offered two possible explanations. First, participants felt that they were de-sensitized because their face information was already available on social media or Face ID. Second, participants believed that face tracking revealed limited personal information, even though this assumption could be alarming, as users' facial features can actually serve as unique biometric identifiers, potentially leading to more unexpected revelation of their physical and physiological data, such as emotional states, geographical information, and medical records.

Despite users' limited privacy concerns regarding FET, a few participants shared their worries. At the interpersonal level, participants felt that exposing their bodily information, including facial expressions and eye movements, would be mentally onerous, as they had to maintain their self-image, which confirms the theory of objective self-awareness. At the organizational level, participants were concerned about how technology corporations might distribute their facial data. Some feared that their facial information could be parsed along with their behavioral data to create access to their personal accounts. Such fear aligns with the tenet of networked privacy, which suggests that individuals may no longer track how their personal information flows across different contexts (Marwick & Boyd, 2014).

Theoretical and methodological implications

First, this study suggests that users perceive violation of interpersonal proxemic norms in VR as inappropriate and develop negative emotional reactions to such violation. Consistent with presence literature, individuals to some degree neglect the differences between mediated and non-mediated environments and transfer the processing of proxemic norm violation from physical spaces to virtual ones.

Second, this study adds a new layer to TSI by revealing the effects of FET on users' own psychophysiological reactions. Enabling or disabling FET might trigger users' objective self-awareness or deindividuation effects, which could affect the evaluation of their own behavior. Our findings point to the potential integration of TSI, objective self-awareness, and deindividuation effects to capture the impact of FET on user perceptions in VR.

Third, this study highlights that the effects of norm violation and face tracking on perceived politeness hinge upon users' gender. Specifically, for men, facial expression disclosure led them to perceive norm violation as more improper, whereas for women, it led them to perceive the same violation as more acceptable. Compared to offline settings, VR introduces a unique social interaction platform where users of different genders may adopt heterogeneous facework to buffer the impact of intrusive behavior in VR and maintain a positive self-image.

Finally, this study applies triangulation (Benoit & Holbert, 2008; Cook, 1985) and strengthens the validity of the study by demonstrating the complementarity of the results. For example, participants' qualitative responses explained why activating FET in VR did not create strong feelings of privacy intrusion. Their mixed attitudes toward norm violation demonstrated the ongoing transition between maintaining interpersonal etiquette in VR and adapting to emerging norms. Further, electrodermal activities objectively signaled participants' physiological arousal, even though norm violation had, to some degree, been normalized on digital platforms.

Practical implications

First, the interaction effects among norm violation, disclosure of facial expressions, and gender on perceived politeness suggest that some novel proxemic norms in VR may be developing. Administrators or platform operators engaged in VR governance should be aware of such variations and keep updating codes of conduct based on users' consensus on certain behavioral norms to encourage a positive use experience while regulating actions that are still considered improper or harmful. Additionally, platform administrators should increase the transparency of the possible effects in VR by reminding users of different genders that norm violation and FET will evoke both cognitive and affective reactions.

Second, understanding how avatars can best represent users may help VR designers prioritize what social cues to track in VR systems (Herrera et al., 2020). Given that FET is a double-edged sword that not only enhances users' engagement but also increases the pressure to manage self-image and privacy,

developers should fully inform VR users of both the promises and perils of activating FET, thereby engaging users in an informed decision-making process.

Conclusions

While VR technologies enhance presence experiences by incorporating various tracking features including face and eye tracking, it is also these features that transform users' social interactions in immersive environments. This study not only confirms that norm violation evokes users' psychophysiological responses like in real places but also uncovers the nuanced impact of face tracking and gender differences. As VR users adapt to new norms in virtual communities, they need to manage their facial expressions to navigate among the promises of an immersive environment, the perils of revealing biometric data, and the pressure of maintaining a positive social impression. This study paves the way for a broader research agenda where utilizing VR's tracking features, analyzing users' psychophysiological responses, and understanding evolving social norms in virtual spaces can form an interrelated triad that mutually affects one another.

This study has some limitations. First, although participants were instructed to walk through/around two confederates in *Horizon Central*, some random VR users joined the confederates and enlarged the group size. The variation in group density might have elicited different levels of physiological arousal (Jeffrey & Mark, 2003). Future research could manipulate different group sizes to understand proxemic norm violation in VR.

Second, it is recommended that GSR be collected when individuals keep their hands still. In our study, although the sensors were attached to the ring and pinky fingers of participants' non-dominant hands, minor hand motion might still have destabilized the GSR signals.

Third, this study tests merely proxemic norm violations. Future research could examine other forms of violations, including unwanted touch, avatar crossing, and hate speech to more comprehensively understand VR users' psychological reactions to norm violation.

Supplementary material

[Supplementary material](#) is available at *Journal of Computer-Mediated Communication* online.

Data availability

The data will be shared on request to the corresponding author.

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Conflicts of interest

None declared.

Open science framework badges

Open Materials

The components of the research methodology needed to reproduce the reported procedure and analysis are publicly available for this article.

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