Effects of Multisensory Feedback and Real-World Priming on Presence and Copresence in Mixed Reality Drone Simulation

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Abstract

Virtual reality (VR) experiences often rely on multisensory cues and realistic interactions to support convincing interpretations of virtual events and agents. This study examines how two factors, real-world priming and multisensory feedback, shape users' perceptions of a virtual drone in a mixed-reality simulation. We conducted a mixed-design experiment where participants experienced either a physical drone flyover or no physical drone encounter, followed by audiovisual and multisensory drone flyovers in VR. Multisensory feedback increased co-presence and perceived realism specifically for participants who had encountered the real drone. In contrast, neither manipulation significantly affected standard presence measures. These findings highlight distinctions among presence-related constructs and suggest that recent real-world experiences can make certain multisensory cues be perceived as more realistic, even when they do not increase presence itself.

Index Terms: Presence, plausibility, virtual reality, priming, multi-sensory, multi-modal, haptics

1 Introduction

Virtual reality (VR) is increasingly used for training and simulation, where the effectiveness of the experience depends on how convincingly users interpret and respond to virtual events and agents. In VR, presence is known as the illusion of *being there* in a virtual scenario, and co-presence is the illusion of another agent being there in the virtual scenario. While presence contributes to engagement in these scenarios, co-presence is critical for tasks involving coordination, supervision, or interaction with autonomous systems [21, 22]. These factors can be improved for a given experience through several design strategies, including realistic interactions between users and the environment, high-quality multisensory feedback, and responsive virtual agents [8, 36]. However, these techniques frequently require additional engineering effort, specialized hardware, or extensive development time.

At the same time, empirical research demonstrates that users can exhibit realistic reactions even in relatively low-fidelity environments, suggesting that the credibility of a virtual experience is shaped not only by system fidelity but also by the expectations and memories users bring with them [32, 20]. This observation raises an appealing possibility for VR training: rather than relying exclusively on complex engineering solutions, we might leverage users' recent real-world experiences to enrich their interpretation and response to virtual scenarios.

If a brief encounter with a real object or system can activate, or perhaps even create, relevant memories and expectations, it may enhance the perceived plausibility of a virtual counterpart. Such an approach could offer a lightweight means of eliciting more realistic user behavior in VR training—particularly in contexts where co-presence and the perceived authenticity of other agents are central to task performance.

In this work, we take a first step toward evaluating this idea by examining whether a short, real-world encounter with a physical drone influences how users perceive a *virtual* drone in a similar VR encounter. We also explore the effect of multisensory feedback, comparing an audiovisual condition to an audiovisual-haptic-olfactory condition. This general approach, originally outlined by Furuya et al. [11], allows us to assess whether recent memories and multisensory cues independently or jointly shape users' judgments of presence, co-presence, and related experiential dimensions.

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2 Related Work

2.1 Presence

Foundational theories of presence describe it as the perceptual illusion of non-mediation, in which users experience virtual events as if they were occurring in the real world [16]. Early work emphasized the importance of place illusion and plausibility illusion, arguing that presence arises when sensory cues and system behavior align with users' expectations about how the world should behave [31, 29]. Empirical studies demonstrated that presence increases when virtual environments support naturalistic interaction, consistent sensory feedback, and coherent environmental responses [37]. More recent work has shown that high-quality motion tracking, embodied avatars, and tight action–perception coupling further strengthen presence by enhancing perceptual coherence [24, 25]. Building on these foundations, Skarbez et al. provided a detailed conceptual analysis of presence and related constructs, clarifying the roles of immersion, coherence, and user expectations in shaping presence in contemporary VR systems [29].

2.2 Co-Presence

Co-presence, the sense of being with another agent, has been theorized as a social analogue to presence, grounded in interpersonal awareness and perceived mutual attention. Foundational work introduced the Networked Minds framework, identifying behavioral contingency, mutual attention, and social feedback as core contributors to co-presence [6]. Early empirical studies demonstrated that social cues such as gaze, posture, and timing strongly influence co-presence in virtual environments [1, 12]. More recent research shows that co-presence increases when virtual agents exhibit human-like motion dynamics, responsive behavior, and appropriate social timing [21, 22]. Collaborative tasks and synchronized actions have also been shown to enhance co-presence by reinforcing perceptions of joint engagement [26, 38]. These findings highlight that co-presence depends on the social and behavioral plausibility of virtual agents, not merely on environmental fidelity.

2.3 Influence of Memories and Expectations

A substantial body of research suggests that users' memories, expectations, and prior experiences shape how they interpret virtual environments. Foundational theories argue that presence depends on the match between virtual cues and users' internal models of the world [28, 31]. Empirical studies show that emotionally salient memories can heighten presence by increasing the personal relevance of virtual events [2, 9]. Complementing this perspective, prior work on social priming shows that briefly observing a virtual human engage in socially meaningful interactions with other agents (including non-humanoid entities such as virtual dogs or robots) can positively bias users' subsequent perceptions and expectations, increasing affective attraction and willingness to engage even when overall presence remains unchanged [19]. Recent work demonstrates that recent real-world experiences can influence how users interpret virtual stimuli, sometimes producing reactions-as-if-real even in low-fidelity environments [20, 23]. These findings suggest that memory-based priors, whether autobiographical, emotional, or freshly activated, may serve as a powerful mechanism for enhancing both presence and co-presence by shaping interpretive expectations.

2.4 Effect of Multisensory Feedback on Presence and Co-Presence

Multisensory feedback has been widely explored as a means of improving presence and co-presence. Foundational work showed that adding haptic cues, either through passive or actuated objects, increases realism and improves users' interpretation of virtual interactions [4, 7, 14]. Olfactory cues have been shown to enhance environmental realism, emotional engagement, and spatial memory [13, 18]. Recent reviews confirm that multisensory integration—including haptic, auditory, and olfactory channels—strengthens presence by increasing perceptual coherence and reducing sensory ambiguity [27]. Empirical studies also show that multisensory cues can enhance co-presence by improving the perceived authenticity of shared objects and agent behaviors [22, 35]. Together, these findings demonstrate that multisensory feedback can meaningfully shape how users perceive both the environment and the agents within it.

To extend this body of work, the present study examines how a brief real-world encounter with a physical drone shapes users' perceptions of a virtual drone in a shared VR environment. By pairing this priming manipulation with a comparison of audiovisual versus audiovisual-haptic-olfactory feedback, we evaluate how recent experiences and multisensory cues jointly influence users' judgments of realism, co-presence, and related experiential dimensions.

3 User Study

3.1 Participants

We performed an a priori power analysis in G*Power [10] to estimate an appropriate sample size. Using a large effect size for a repeated measures, within-between interaction ANOVA with $\eta_p^2 = 0.14$ and standard values of $\alpha = 0.05$ and $1-\beta = 0.8$, we estimated a minimum sample size of 16 participants. Based on this approximation, we recruited a convenience sample of $N = 20$ (Male = 11, Female = 9) participants from our university community through email listings. To be eligible, participants were required to be over the age of 18 with normal or corrected-to-normal vision and no color blindness, strong eye dominance, night blindness, balance disorders or fragrance allergies. Each participant received monetary compensation for participating.

3.2 Experiment Design

We conducted a 2×2 split-plot, mixed design user study ($N = 20$) to explore the effects of multisensory feedback and real-world priming on participants' levels of presence and engagement with drones. This mixed design used presence of priming (**Flyover**, **No Flyover**) as the between-subjects factor and level of sensory feedback (**Audiovisual**, **Multisensory**) as the within-subjects factor. The resulting conditions are shown in Table 1.

Table 1: Split-plot design of the experiment

		Priming Method (Between-Subjects)	
Feedback Type (Within-Subjects)		Flyover (FO)	No Flyover (NFO)
	Multisensory (MS)	(FO, MS)	(NFO, MS)
	Audiovisual (AV)	(FO, AV)	(NFO, AV)

3.2.1 Priming Experience

Half of the participants were randomly assigned a **real-world priming** experience in which a small UAV performed a flyover above the participants' heads. In this experience, participants watched a drone take off from the ground, ascend, fly horizontally to a spot above their heads, pause, fly back horizontally, then descend and land.

3.2.2 Sensory Feedback

Each of our participants experienced two VR simulated UAV flyovers with either **audiovisual feedback** or **multisensory feedback**, the order of which was randomly assigned. For participants that only experienced *audiovisual feedback*, they observed a virtual drone fly-over in the virtual environment. As the drone flew overhead, the participants heard the sound of the drone flying. For participants in the *multisensory feedback* condition, they also experienced tactile and olfactory feedback through an overhead fan mimicing the wind created by a real drone, a patch of artificial turf flooring, and an automated scent diffuser (see Figure 1). The scent diffuser dispensed a scent produced by citrus essential oils and served as a general multisensory enhancement. Unlike the artificial turf, participants did not touch or physically handle the scent diffuser. Each of these physical stimuli were represented by virtual objects registered to the correct positions in the virtual environment (see Figure 3). The virtual scent diffuser additionally displayed a particle effect when the physical diffuser was turned on. The virtual scent diffuser's activation was synchronized with the physical scent diffuser's activation in the multisensory condition to enhance the effect of the olfactory feedback. In the case of the overhead fan, the fan would turn on when the virtual drone flew near the participant in VR, and would turn off once the drone flew away.

3.3 Materials

3.3.1 Equipment

The experiment was developed using Unity version 2022 LTS. The experiment was run untethered on a Meta Quest 3 HMD with a resolution of 2064 × 2208 pixels per eye with an approximately 122-degree diagonal field of view and a refresh rate of 90 Hz. A DJI Tello EDU[1] was used as the flyover drone, controlled using the DJITelloPy python library[2]. Participants used a Quest Touch Plus[3] hand-held controller as the input device for providing survey responses during the experiment. For tactile feedback, we placed artificial turf flooring under the participants' feet and a Vornado EXO51 Air Circulator[4] overhead. For olfactory feedback, we placed an Asakuki Smart Essential Oil Diffuser[5] next to the participant. A smart outlet compatible with Tuya Smart[6] was used to turn the overhead fan on and off. We used the Tuya.NET library[7] to

[1] https://store.dji.com/product/tello-edu
[2] https://pypi.org/project/djitellopy/
[3] https://www.meta.com/quest/accessories/quest-touch-plus-controller
[4] https://www.vornado.com/shop/circulators-fans/small/exo51-heavy-duty-small-air-circulator
[5] https://asakuki.com/
[6] https://www.tuya.com/
[7] https://github.com/ClusterM/tuyanet

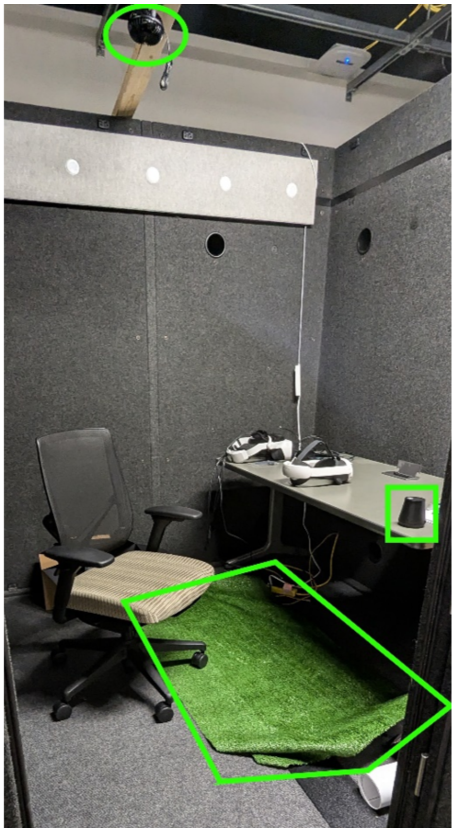

Figure 1: Sound Isolation Booth for viewing VR drone flyover, with turf carpet, scent diffuser, and overhead fan hightlighted.

facilitate requests from the Unity client to operate the essential oil scent diffuser and the smart outlet.

3.3.2 Physical Environment

These VR experiences took place in a sound isolation booth, shown in Figure 1, within the lab that contained an overhead fan, artificial turf flooring, and an automated scent diffuser.

During the real drone flyover, participants sat in a netted cage that was constructed in our lab space which featured artificial turf flooring for tactile feedback and a nearby automated scent diffuser for olfactory feedback, as seen in Figure 2.

3.3.3 Virtual Environment

A virtual replica of the laboratory space, seen in Figure 3, was constructed to match the physical environment in which the study took place. The ceiling and the two walls surrounding the participant seating area were captured using photogrammetry with Polycam[8], allowing their geometry and surface detail to be reproduced accurately in VR. The floor was modeled using a carpet texture selected to closely resemble the pattern and coloration of the real laboratory flooring. A virtual scent diffuser was positioned in the same relative location as the physical diffuser used in the flyover condition to maintain spatial consistency across conditions. The DJI Tello EDU drone was recreated by making minor modifications to an existing 3D model created by Temoor and shared on SketchFab[9].

[8] https://poly.cam/

[9] https://sketchfab.com/3d-models/dji-tello-36365bad0ebd46428e6241676725dcec

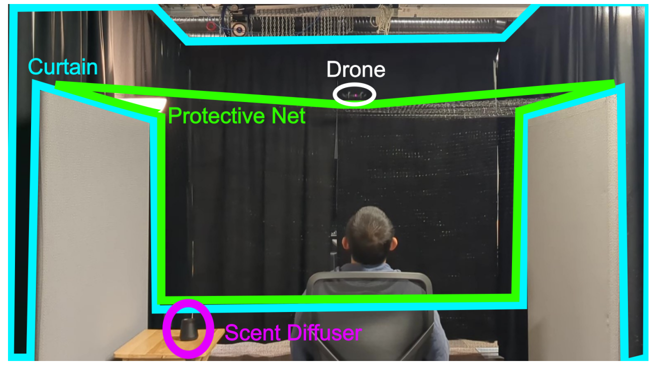

Figure 2: Real-world priming setup, with a protective net through which participants viewed a drone flying over head and a scent diffuser next to the participant.

3.4 Measures

To assess participants' experiences of presence and co-presence during the virtual drone flyovers, we administered three established self-report questionnaires.

Basdogan Co-Presence Questionnaire Co-presence was measured using the Basdogan Co-Presence questionnaire [5], which assesses the extent to which participants feel the presence of, awareness of, and connection to another agent within a shared virtual environment. The instrument consists of eight items rated on a 7-point Likert scale and has been widely used to evaluate co-presence in collaborative and agent-based VR scenarios Higher scores indicate a stronger sense that another agent is present and behaving meaningfully within the shared space.

Slater–Usoh–Steed (SUS) Presence Questionnaire Overall presence was measured using the Slater–Usoh–Steed (SUS) Presence questionnaire [33, 34, 30]. The SUS is a short, widely adopted measure designed to capture the subjective illusion of "being there" in a virtual environment. It consists of six items rated on a 7-point Likert scale that probe participants' sense of physical location, immersion, and involvement in the virtual scene. Mean SUS scores provide a global index of presence and are commonly used as a benchmark presence measure in VR research.

Temple Presence Inventory (TPI) Multidimensional aspects of presence and realism were assessed using selected subscales of the Temple Presence Inventory (TPI) [17]. The TPI decomposes presence-related experience into multiple dimensions, allow-

Figure 3: Virtual environment recreation of the real laboratory space, matching the real-world setup seen in Figure 2.

ing finer-grained analysis beyond a single global presence score. In this study, we analyzed four TPI subscales: Spatial Presence, Engagement, Social Realism, and Perceived Realism. These subscales capture participants' perceived sense of spatial immersion, psychological involvement, plausibility of social events, and realism of the virtual environment, respectively, providing a richer characterization of how priming and multisensory feedback shaped experiential outcomes.

3.5 Procedure

Upon arriving to the laboratory, participants were briefed on the experiment and gave informed consent. They were then fitted with the VR head-mounted display (HMD) and allowed to adjust the interpupillary distance such that the picture was as clear as possible. After getting fitted with the HMD, participants removed the HMD and moved to a desktop to fill out a drone familiarity questionnaire and an Immersive Tendencies Questionnaire [37]. Once the questionnaire were completed, participants underwent text-based priming by reading a printout about small drones. Participants in the real-world priming group experienced an additional priming of a real UAV flyover. For more information on the priming experiences see Section 3.2.1. Participants were also directed to look at a scent diffuser as it was turned on and instructed to indicate when they could smell the diffused scent. Participants were also instructed to rub their feet on a patch of artificial turf placed at their feet. Following priming, participants completed a pre-exposure Simulator Sickness Questionnaire (SSQ) [15].

Next, participants moved to the soundproof booth (See Figure 1) and donned the VR HMD for the first sensory experience where they observed a simulated UAV flyover. In both multisensory and audiovisual conditions, participants were asked to look at the virtual scent diffuser and virtual turf patch present in the environment. Participants were instructed to press a button to turn on the virtual scent diffuser, watch the virtual scent particles, and indicate if they could smell anything. In the multisensory condition, the real scent diffuser would turn on at this time. Participants were also instructed to rub their feet on virtual artificial turf at their feet. In the multisensory condition, there would be a real patch of artificial turf at their feet in the same location as the virtual turf. Participants were then instructed to press a button to initiate a virtual drone flyover. In the multisensory condition, the overhead fan would turn on as described in Section 3.2.1. Each task completed in VR took about 5 to 10 seconds.

After the simulated flyover, participants completed the SUS Presence Questionnaire, the Temple Presence Inventory, and the Basdogan Co-presence questionnaire in the headset. Questionnaire data was collected using the Virtual Experience Research Accelerator (VERA) Unity plugin [10]. Participants completed another SSQ before donning the HMD again for their second sensory experience. They again completed the SUS Presence Questionnaire, the Temple Presence Inventory, and the Basdogan Co-presence questionnaire in the headset. Although administering questionnaires after each experience rather than after all experiences may have affected participants' attention and immersion, it ensures that participants' memories of the experiences do not mix due to their similarities. Following the completion of the questionnaires, participants removed the HMD to read and respond to their second scenario, completed a post-exposure SSQ, and a demographics questionnaire.

3.6 Hypotheses

H1 Real-world priming methods will improve presence.

H2 multisensory feedback factors will improve presence.

[10] https://vera.research.ucf.edu/

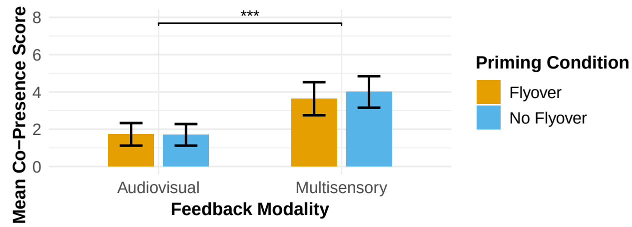

Figure 4: Mean Basdogan Co-Presence Score (0–8) across feedback modalities and priming conditions. Triple asterisks indicate a significant main effect of feedback ($p < .001$).

H3 Real-world priming without real-world feedback will improve presence more than real-world feedback without real-world priming.

4 Results

4.1 Analysis Method

We analyzed each of the measures using mixed models. In each case, we include the two main factors as fixed effects. We also evaluated goodness of fit between these models and models including other demographic factors we collected, e.g., prior experience and knowledge of both drones and VR systems. In all cases the simpler models featuring only the main factors were preferred by both AIC and BIC.

4.2 Presence and Co-Presence

Basdogan Co-presence The Basdogan Co-Presence questionnaire was analyzed by dichotomizing each response as 1 if the rating was greater than or equal to 6, and 0 otherwise [3, 5]; ratings of 6 or 7 on the original 7-point scale are classified as "high" co-presence, and all lower ratings were classified as "low." Each participant's dichotomized item scores were then summed to yield an integer co-presence score ranging from 0 to 8 per condition, representing the number of items on which the participant reported high co-presence.

We fit a binomial generalized linear mixed model predicting the number of successful co-presence responses (out of eight) from Priming (Flyover vs. No Flyover), Feedback modality (Audiovisual vs. Multisensory), and their interaction, with participant included as a random intercept. The model revealed a significant main effect of Feedback, indicating that Multisensory feedback produced higher co-presence success rates than Audiovisual feedback ($\beta = 1.47$, SE = 0.40, $z = 3.69$, $p < .001$). In contrast, Priming did not significantly affect co-presence responses ($\beta = 0.03$, SE = 0.78, $z = 0.04$, $p = .97$), nor was there a significant Priming $\times$ Feedback interaction ($\beta = 0.27$, SE = 0.58, $z = 0.47$, $p = .64$). Random intercept variance indicated substantial between-participant variability ($\sigma^2 = 2.06$). Overall, Multisensory feedback reliably increased co-presence-related behavioral responses, independent of priming condition. These results are illustrated in Figure 4.

Slater-Usoh-Steed (SUS) Presence Mean presence scores were computed for each participant and condition by averaging the six items of the Slater–Usoh–Steed (SUS) presence questionnaire [33, 34, 30]. These mean scores (range 1–7) were analyzed using a linear mixed-effects model with fixed effects of Priming (Flyover vs. No Flyover), Feedback modality (Audiovisual vs. Multisensory), and their interaction, and random intercepts for participants. The model revealed no significant main effect of Priming ($\beta = -0.65$, SE = 0.48, $t = -1.36$, $p = .19$), no significant main effect of Feedback ($\beta = 0.35$, SE = 0.32, $t = 1.10$, $p = .29$), and no significant Priming $\times$ Feedback interaction ($\beta = 0.26$, SE = 0.44,

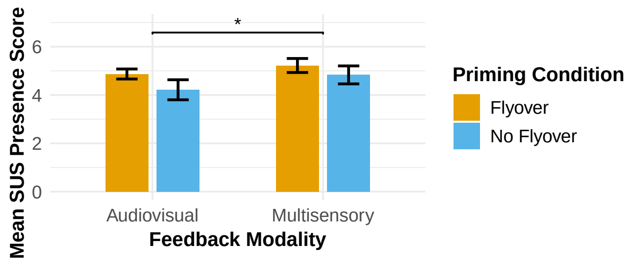

Figure 5: Mean SUS Presence Score (1–7). The bracket indicates a significant increase in presence for Multisensory relative to Audiovisual feedback ($p = .035$).

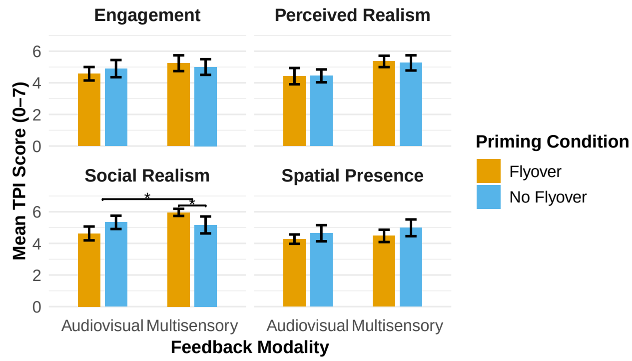

Figure 6: Mean TPI Scores (0–7) for Engagement, Perceived Realism, Social Realism, and Spatial Presence. Significance brackets within the Social Realism facet highlight the Feedback main effect and the Priming × Feedback interaction.

$t = 0.60$, $p = .55$). Residual diagnostics indicated no major violations of normality or homoscedasticity.

Because the SUS is commonly interpreted using mean item scores [33, 34], we conducted confirmatory paired t-tests to evaluate the within-subjects effect of Feedback. This analysis revealed a small but significant increase in mean presence for the Multisensory condition relative to the Audiovisual condition ($t(18) = 2.28$, $p = .035$, mean difference $= 0.49$). No significant difference was observed between Priming conditions in an independent-samples t-test. Internal consistency of the six SUS items was acceptable (Cronbach's $\alpha = .75$), consistent with prior reports for the SUS presence scale [30]. Figure 5 displays the mean presence scores across conditions.

Temple Presence Inventory We analyzed four TPI subscales (Spatial Presence, Engagement, Social Realism, and Perceived Realism) using linear mixed models with random intercepts for participants. Each model included Priming (Flyover, No Flyover) as a between-subjects factor and Feedback (Audiovisual, Multisensory) as a within-subjects factor.

For Spatial Presence, neither the main effect of Priming, $t(21.16) = 0.58$, $p = .566$, nor the main effect of Feedback, $t(17) = 0.67$, $p = .513$, nor their interaction, $t(17) = 0.32$, $p = .752$, reached significance. Estimated marginal means ranged from 4.27 to 4.99 across conditions.

For Engagement, no significant effects were observed. Priming, $t(26.21) = 0.46$, $p = .647$, Feedback, $t(17) = 1.37$, $p = .189$, and the interaction, $t(17) = -0.84$, $p = .410$, were all non-significant. Estimated marginal means ranged from 4.57 to 5.24.

For Social Realism, there was a significant main effect of Feedback, $t(17) = 2.66$, $p = .017$, with Multisensory feedback producing higher realism ratings than Audiovisual feedback. This effect was qualified by a significant Priming × Feedback interaction, $t(17) = -2.17$, $p = .045$. Multisensory feedback increased realism for Flyover-primed participants (from 4.63 to 5.96), but not for No Flyover participants (from 5.33 to 5.17).

For Perceived Realism, no significant effects were found. Priming, $t(32.90) = 0.03$, $p = .978$, Feedback, $t(17) = 1.59$, $p = .129$, and the interaction, $t(17) = -0.14$, $p = .890$, were all non-significant. Estimated marginal means ranged from 4.42 to 5.36. Overall, Social Realism was the only TPI dimension showing a reliable experimental effect, with Multisensory feedback improving realism primarily for Flyover-primed participants. The full TPI subscale results are visualized in Figure 6.

5 Discussion

The pattern of results across presence, co-presence, and the TPI subscales provides insight into how participants interpreted the Multisensory virtual experience. The Social Realism findings are particularly informative. Social Realism concerns whether the events observed in the virtual environment "would", "could", or "should" occur in the real world [17]. The interaction between Priming and Feedback for this measure suggests that participants who physically encountered the drone and scent diffuser during the Flyover priming were better able to recognize the improved realism afforded by the Multisensory feedback. Experiencing the real devices appears to have provided a reference point that made the Multisensory cues more intelligible as realistic rather than merely vivid.

At the same time, this increase in the Social Realism scores, and potentially recognition of realism, was not accompanied by corresponding increases in presence. This dissociation aligns with recent work demonstrating that realism and presence are related but separable experiential dimensions [36, 28]. Participants may have been able to judge the Multisensory cues as more realistic without necessarily feeling more present in the virtual environment, reinforcing the distinction between perceptual fidelity and the subjective sense of "being there."

The pattern becomes more intriguing when considering the Basdogan Co-Presence scores. Multisensory feedback increased co-presence, yet this effect did not interact with Priming. If Social Realism were the primary driver of co-presence, one would expect the same interaction pattern to appear. Conversely, if presence were the primary driver, one would expect no main effect of Feedback at all. The fact that co-presence increased under Multisensory feedback despite the absence of parallel effects in presence or Social Realism suggests that the perception of the drone's co-presence may have been influenced by factors outside the scope of the experimental manipulations.

Participant interviews provide additional insight into how the Multisensory cues were interpreted. Many participants praised the scent diffuser in the Multisensory condition, noting the realistic delay between activating the diffuser and detecting the scent. Because the system used a real scent diffuser positioned where the virtual diffuser appeared, the temporal and spatial characteristics of the scent delivery aligned closely with real-world expectations. In contrast, participants in the Flyover group frequently noted that the overhead fan used to simulate drone airflow did not match the timing, sound, or strength of the real drone they had just experienced. These qualitative reports highlight a meaningful asymmetry in the fidelity of the Multisensory cues: the scent diffuser provided a highly realistic signal, whereas the airflow simulation did not. Given these differences, it is unexpected that the Multisensory feedback condition nonetheless produced higher co-presence ratings. If co-presence were tightly coupled to the realism of specific sensory cues, one might expect the weaker airflow simulation to diminish the effect. Instead, the increase in co-presence suggests that participants may have been responding to broader aspects of Multisensory engagement—such as the mere presence of additional sensory channels, the perceived responsiveness of the system, or interpretive framing—rather than to the realism of any single cue. This interpretation aligns with perspectives that view co-presence as emerging from a variety of interconnected perceptual, cognitive, and social factors, many of which may fall outside the boundaries of controlled experimental manipulations [21, 22].

Future work may consider utilizing multiple narrative and experiential tools to address multiple factors at once. Traditional priming instruments, such as videos or text vignettes, can be used in conjunction with, or compared to, a more contextualized real-world encounter. The difficulty in creating realistic wind effects for an experience as simple as a drone flyover reinforces the value in exploring alternative means for improving co-presence in simulation and training experiences.

6 Conclusion

This study examined how real-world priming and multisensory feedback influence users' perceptions of a virtual drone in a mixed-reality simulation. Multisensory feedback increased co-presence and enhanced social realism for participants who had encountered the real drone, suggesting that recent experiences can shape how specific sensory cues are interpreted in VR. At the same time, neither Priming nor Multisensory feedback affected standard presence measures, highlighting differences between feeling present, judging events as realistic, and perceiving another agent as co-present. These results point to opportunities for VR training systems to use targeted sensory cues and brief real-world interactions to influence how virtual agents and events are understood, even when overall presence remains unchanged.

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