

Effect of Facial Realism on Presence in Collaborative Virtual Environments

Investigating the Effect of Avatars with Eye and Mouth-Tracked Facial Expressions

Background

Presence is understood as the feeling of “being there” in a virtual environment. It can be conceptualised as three types: physical presence, social presence, and self-presence [1].

These three types of presence are an important part of immersion in VR spaces, which is vital for social VR applications. An active area of research is approaches to avatar design to increase user presence, for instance avatars with higher behavioural realism [2].

Research Question

To what extent does facial realism of an avatar, operationalized through adding eye- and mouth-tracking, impact the feeling of presence in a collaborative virtual environment, when compared to an avatar with only head and hands tracking?

This question will be answered through subquestions corresponding to the different kinds of presence.

Methodology

1. Create a virtual avatar supporting eye rotation, pupil dilation, eye open/close and various mouth shapes. Implemented using Unified Expressions standard [3].
2. Animate the avatar with eye- and mouth-tracking data from VR head-mounted displays.
3. Perform a controlled experiment where user pairs have a face-to-face social interaction in VR, piloting avatars with either: (Static) a static neutral face, (Eye) with only eye-tracked expressions, or (Full) with eye- and mouth-tracked expressions.
4. Compare presence questionnaire results, determine if differences exist between these conditions.



Figure 1. Example facial expressions. In reading order: (1) basis, (2) look up left with 4 animation shapes, (3) look right and left lid close with 2 animation shapes, (4) complex expression combining 12 animation shapes.

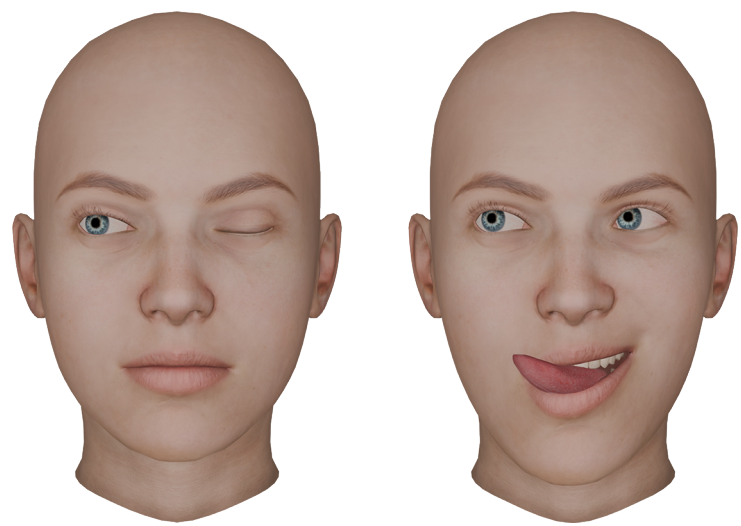


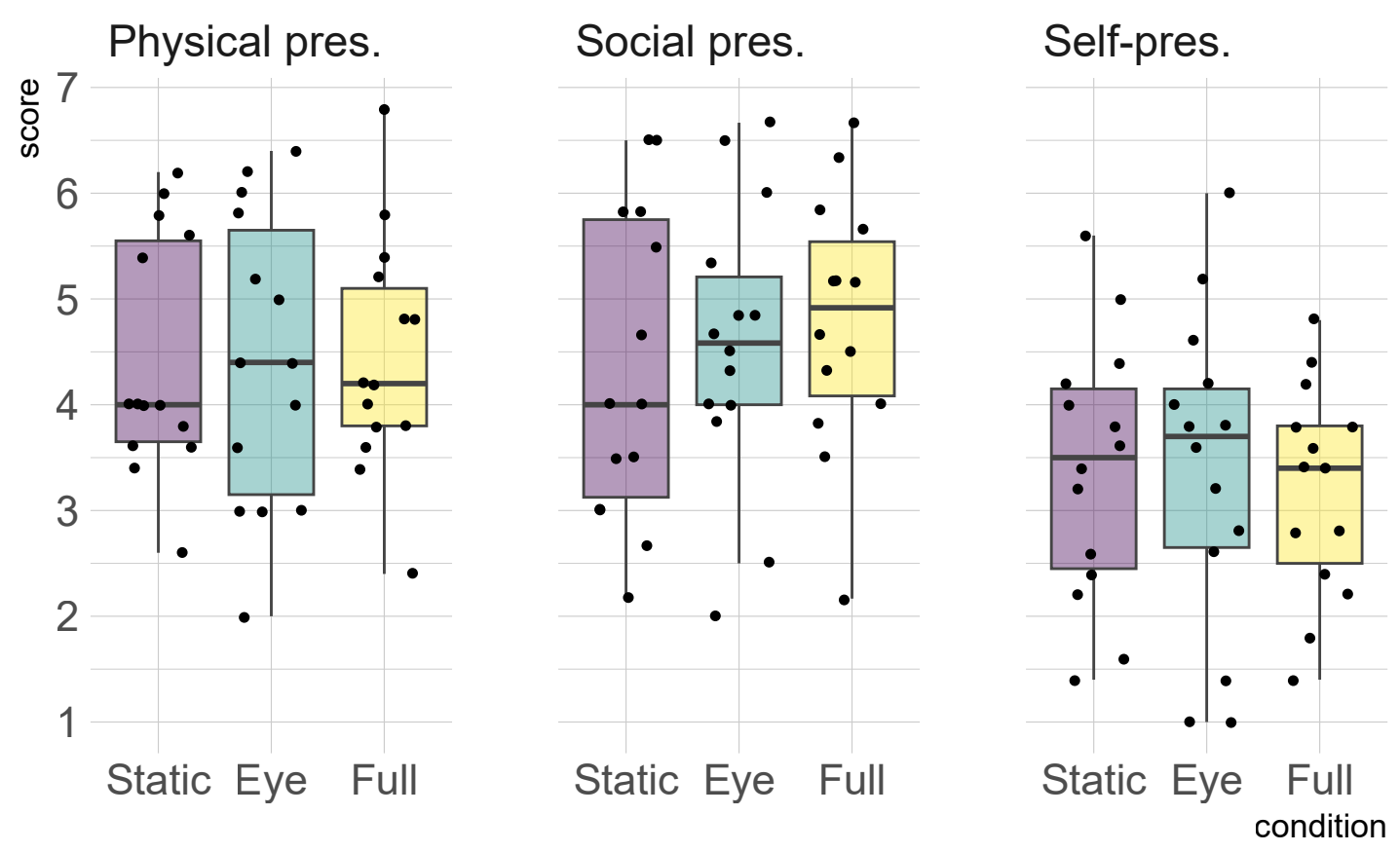
Figure 2. Avatar representation in base pose

Results

No significant differences for any presence scale between conditions were found.

Individually, two questions were significant, and three were marginally significant.

Participants reported lower feeling of the VR interface disappearing and directly interacting with another person (Q11, $p = 0.03$), and lower feeling of correspondence between virtual experiences and their physical body (Q17, $p = 0.02$), in condition Full compared to Static.



Marginally significant

Improved ability to assess reactions of partners in Full compared to Static (Q7, $p = 0.07$).

Decreased feeling as well for Q11 ($p = 0.08$) and Q17 ($p = 0.07$), as described before, in Eye compared to Static.

Table 1 Significance Scores for Individual Questionnaire Items (Partial)

Q	Static Face $M \pm SD$	Eye Tracked $M \pm SD$	t	Full Tracked $M \pm SD$	t
Q7	3.86 ± 1.75	3.86 ± 1.51	0.00	4.71 ± 1.59	1.88*
Q11	4.50 ± 1.99	4.00 ± 1.88	-1.84*	3.86 ± 1.66	-2.36*
Q12	4.21 ± 2.04	4.57 ± 2.03	1.19	4.36 ± 2.06	0.48
Q17	3.07 ± 1.44	2.64 ± 1.45	-1.87*	2.50 ± 1.02	-2.50*

Note: M = mean, SD = (sample) standard deviation, t = t -score
* = $0.01 < p < 0.05$, * = $p < 0.1$

Limitations

Low sample size ($n = 14$). Some evidence has been found that repetition of the experiment with a larger sample size is desirable and may yield significant results for social presence.

Advice for future research to consider other interactions than the 20 Questions game, users tend to look away rather than at their partner.

Conclusions

No significant differences found between conditions. Some significant results for individual questions, which point to increased ability to assess partner’s reactions, but reduced correspondence between virtual experience and user’s physical body, as facial realism increases. Advice provided for future research.

- use an interaction with incentive to look at partner.
- consider faster, high-accuracy mouth tracking, like marker-based or depth camera.

Future work

Repeat the experiment with suggested changes Investigate additional expressions like brow, nose. Possibilities for artificially enhancing tracked expressions

References

[1] K. M. Lee, ‘Presence, Explicated’, *Commun Theory*, vol. 14, no. 1, pp. 27–50, Feb. 2004, doi: 10.1111/j.1468-2885.2004.tb00302.x.
 [2] F. Herrera, S. Y. Oh, and J. N. Bailenson, ‘Effect of Behavioral Realism on Social Interactions Inside Collaborative Virtual Environments’, *Presence: Teleoperators and Virtual Environments*, vol. 27, no. 2, pp. 163–182, Feb. 2018, doi: 10.1162/pres_a_00324.
 [3] ‘Unified Expressions | VRFaceTracking’. Accessed: May 15, 2024. [Online]. Available: <https://docs.vrcft.io/docs/tutorial-avatars/tutorial-avatars-extras/unified-blendshapes>