Stop Peeking: What Mechanisms Underlie Gaze Awareness?

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Abstract

Shared gaze can support collaboration in various Extended Reality (XR) tasks and applications through shared attention. However, there is limited research on how shared gaze, and the awareness that others can see one's gaze, influences gaze behavior. When the gaze of people is visualized in a collaborative setting, it is likely that gaze behavior changes compared to situations without shared gaze. Furthermore, other social interactions might also be affected by making gaze visible. We aim to investigate whether and how people adapt their gaze in response to shared gaze and if general behavior is altered. To this end, participants perform collaborative tasks in a shared XR environment where gaze is continuously visualized. Importantly, participants are not always aware of whether their own gaze is visible to their partner, providing insight into how perceived observation influences both gaze patterns and social interactions in collaborative XR environments.

Keywords

Shared gaze, gaze awareness, gaze behavior, collaborative XR

1. Introduction

Communication is essential for human collaboration and coordination. While verbal communication is important, non-verbal signals such as body language and gaze play a critical role in shaping social interaction. Gaze, in particular, conveys mental states, guides others' attention, and signals intentions [1]. Gaze has two aspects: the signal and the meaning. The signal captures properties such as the dynamics of eye movements, whereas the meaning consists of how these signals are interpreted. These two aspects align when gaze is not random but intentionally directed, conveying information to others [2]. Without a visualized gaze point, others can locate the gaze point as well, but only as a conscious action. When gaze is shared the interpretation of the gaze point becomes immediately relevant. This visibility might influence how people direct or limit their gaze to convey intention or to avoid sending unintended or inappropriate signals [3].

Shared gaze is examined in many different collaborative settings. In Augmented Reality (AR) setups where the eyes are hidden behind the headset, seeing the other person's gaze was assumed to compensate this. Shared gaze can improve joint attention as well as coordination and communication in collaborative tasks [4]. It can also be used for rapid spatial referencing and for focusing on the same object or location. By reducing the need for verbal communication, it simplifies grounding and makes interaction more efficient [5].

While shared gaze and its benefits in collaborative XR settings is intensively examined there is to the best of our knowledge no research on how gaze behavior is altered when people are aware of the fact that their gaze is revealed to others.

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2. Related Work

2.1. Shared Gaze as a Coordination Aid

Shared gaze can speed up spatial referencing and agreeing on an aim compared to using voice [6]. Another study showed that shared gaze can improve several quality aspects for academic writing in remote dyadic settings [7], and was useful in remote drawing processes as it enhanced spatial awareness. Interestingly it also caused less turn-taking and less verbally complex sentences in conversations [8, 5]. The cognitive load can also be reduced when gaze is shared and common understanding improves [5]. When using shared gaze in remote puzzle tasks it is especially beneficial and compensates the remoteness when the task complexity gets higher [9]. Depending on the task which is performed shared gaze in co-located collaborative settings caused improvement or decline of performance [10, 11].

2.2. Social Implications of Shared Gaze

If people are not aware of their gaze being shared, the eye movements become less intentional and tend to be not as useful for instructions and explanations [12].

When shared gaze is transferred to co-located setups, new challenges come up. In co-located setups shared gaze can lead to ignoring other naturally existent social cues and only focus on the gaze of other people. In addition to that comes the attention dilemma. This describes the fact that gaze is not only an output used to explicitly communicate and contain information, it is primarily an input channel to observe and absorb information. When every gaze point could contain information, people might limit their perception to not send wrong signals. This is especially likely to happen in competitive scenarios, where as little information or intentions as possible should be revealed [3].

When partners in co-located collaborative setups control each others' gaze, the shared gaze can have a negative impact on the partnership and can lead to a higher level of distraction. Therefore, the gaze visibility might also need to be turned off, which is on the other side again an explicit signal, which can be interpreted by the other person in several ways [13].

2.3. Impact of Shared Gaze on Gaze Behaviour

There are some measures that cannot be investigated without being manipulated, to the degree where they do not picture reality anymore. This manipulation can happen because of participants altering their behavior if they are observed in studies if they consider it inappropriate. This was first described by the Hawthorne effect [14].

This can also be applied to observing gaze behavior. When gaze is shared, it cannot be assumed that this shared gaze behavior is equivalent to the person's natural gaze behavior.

3. Study Design

Based on previous work on collaborative XR environments, we plan to investigate how the awareness of gaze visibility to others influences gaze behavior and gaze strategies during collaborative XR tasks. Rather than manipulating whether gaze is shared, the study focuses on the awareness of gaze visibility while keeping the gaze visualization itself constant across conditions. The following research questions are addressed:

- Do participants when they are aware that their gaze is visible show a more deliberate and less exploratory gaze behavior, characterized by longer fixation durations and fewer rapid saccades?
- Do participants when they are aware of gaze visibility try to communicate explicitly using their gaze compared to when they are not aware of gaze visibility?
- Do participants when they are aware of gaze visibility look less at socially sensitive areas than when they are not aware of gaze visibility?

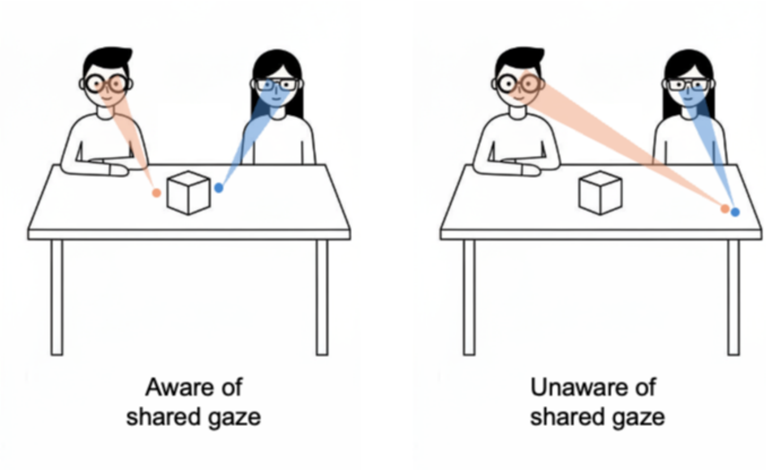

Figure 1: Exemplary study setup.

3.1. Experimental Design

A within-subject design with two experimental conditions will be used. Participants are paired into dyads and perform collaborative tasks while their gaze is continuously tracked and visualized to their partner in both conditions. In the *aware condition*, participants are explicitly informed that their gaze point is visible to the other participant in real time. In the *unaware condition*, participants are informed that their gaze is not visible to their interaction partner.

Although they can still observe the partner's gaze, they are instructed not to disclose this information. However, the gaze visualization remains present in the shared environment. The order of the two conditions is counterbalanced to control for learning and order effects.

3.2. Tasks

Participants perform collaborative tasks that require joint attention and coordination. To cover different forms of collaboration, three task types are included:

- *Search tasks*, in which participants jointly search for target objects in the environment.
- *Object selection tasks*, which require identifying and selecting objects based on shared criteria.
- *Spatial referencing tasks*, in which participants refer to objects or locations using spatial descriptions.

These task types were chosen because they naturally allow gaze to serve as a potential communicative cue, while still requiring active coordination between participants.

3.3. Measures and Data Analysis

Gaze behavior will be analyzed using objective eye-tracking metrics, including the number of fixations, fixation duration, saccade frequency, and gaze dispersion. These measures capture differences in gaze exploration, gaze control, and intentionality between awareness conditions. Subjective experience is assessed through a questionnaire following the experiment. Awareness of being observed is measured using Likert-scale items focusing on perceived observation, gaze-related self-monitoring, and social self-consciousness.

Statistical analyses focus on comparisons between the aware and unaware conditions. Gaze metrics will be analyzed using repeated-measures statistical tests. In addition, correlations between subjective awareness ratings and objective gaze measures can be examined to explore the relationship between perceived observation and gaze behavior.

3.4. Ethical Considerations

Participants are fully informed about the use of eye tracking and the recording of gaze data. At the end of the study, participants are debriefed about the visibility of gaze in both conditions.

4. Conclusion

This work proposes a study design to investigate how the awareness of gaze visibility influences gaze behavior in collaborative XR environments. By separating awareness from actual gaze visualization, the design aims to show how awareness alone affects social and cognitive behavior. Understanding the role of awareness is relevant for the design of collaborative XR systems. If gaze behavior changes when users know it is visible, this may affect coordination, communication, and social dynamics. It should therefore be considered when and how gaze information is shared and whether users should be able to control its visibility. Future empirical studies based on this design can help clarify the dual role of gaze as both an input mechanism and a communicative signal in immersive environments.

Declaration on Generative AI

During the preparation of this work, the author used Perplexity AI for Figure 1 in order to generate the image. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the publication's content.

References

[1] A. Frischen, A. P. Bayliss, S. P. Tipper, Gaze cueing of attention: Visual attention, social cognition, and individual differences, Psychological Bulletin 133 (2007) 694–724. doi:10.1037/0033-2909.133.4.694.

[2] C. Pelachaud, Eye communication in a conversational 3D synthetic agent, AI Communications (2000).

[3] V. van Rheden, B. Maurer, D. Smit, M. Murer, M. Tscheligi, LaserViz: Shared gaze in the co-located physical world, in: Proceedings of the Eleventh International Conference on Tangible, Embedded, and Embodied Interaction, TEI '17, Association for Computing Machinery, New York, NY, USA, 2017, pp. 191–196. doi:10.1145/3024969.3025010.

[4] A. Jing, K. May, G. Lee, M. Billinghurst, Eye see what you see: Exploring how bi-directional augmented reality gaze visualisation influences co-located symmetric collaboration, Frontiers in Virtual Reality 2 (2021). doi:10.3389/frvir.2021.697367.

[5] A. Jing, K. May, B. Matthews, G. Lee, M. Billinghurst, The impact of sharing gaze behaviours in collaborative mixed reality, Proceedings of the ACM on Human-Computer Interaction 6 (2022) 463:1–463:27. doi:10.1145/3555564.

[6] M. B. Neider, X. Chen, C. A. Dickinson, S. E. Brennan, G. J. Zelinsky, Coordinating spatial referencing using shared gaze, Psychonomic Bulletin & Review 17 (2010) 718–724. doi:10.3758/PBR.17.5.718.

[7] G. H. Kütt, K. Lee, E. Hardacre, A. Papoutsaki, Eye-write: Gaze sharing for collaborative writing, in: Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, CHI '19, Association for Computing Machinery, New York, NY, USA, 2019, pp. 1–12. doi:10.1145/3290605.3300727.

[8] E. Ma, P. Dixit, A. Han, N. Marsano, B. Sparks, A. Sun, L. Tiangco, T. Zhou, J. Huang, A. Papoutsaki, EyeDraw: Investigating the perceived effects of shared gaze on remote collaborative drawing, Proceedings of the ACM on Human-Computer Interaction 9 (2025) GROUP17:1–GROUP17:24. doi:10.1145/3701196.

[9] S. D'Angelo, D. Gergle, Gazed and confused: Understanding and designing shared gaze for remote collaboration, in: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, CHI '16, Association for Computing Machinery, New York, NY, USA, 2016, pp. 2492–2496. doi:10.1145/2858036.2858499.

[10] G. H. Kütt, T. Tanprasert, J. Rodolitz, B. Moyza, G. So, G. Kenderova, A. Papoutsaki, Effects of shared gaze on audio- versus text-based remote collaborations, Proceedings of the ACM on Human-Computer Interaction 4 (2020) 136:1–136:25. doi:10.1145/3415207.

[11] J. S. McCarley, N. Leggett, A. Enright, Shared gaze fails to improve team visual monitoring, Human Factors 63 (2021) 696–705. doi:10.1177/0018720820902347.

[12] D. Akkil, B. Thankachan, P. Isokoski, I see what you see: gaze awareness in mobile video collaboration, in: Proceedings of the 2018 ACM Symposium on Eye Tracking Research & Applications, ETRA '18, Association for Computing Machinery, New York, NY, USA, 2018, pp. 1–9. doi:10.1145/3204493.3204542.

[13] Y. Zhang, K. Pfeuffer, M. K. Chong, J. Alexander, A. Bulling, H. Gellersen, Look together: using gaze for assisting co-located collaborative search, Personal and Ubiquitous Computing 21 (2017) 173–186. doi:10.1007/s00779-016-0969-x.

[14] P. Sedgwick, N. Greenwood, Understanding the Hawthorne effect, BMJ 351 (2015) h4672. doi:10.1136/bmj.h4672.