Awkward or Acceptable? Understanding the Bystander Perspective on the Ubiquity of Cross Reality in Ambiguous Social Situations

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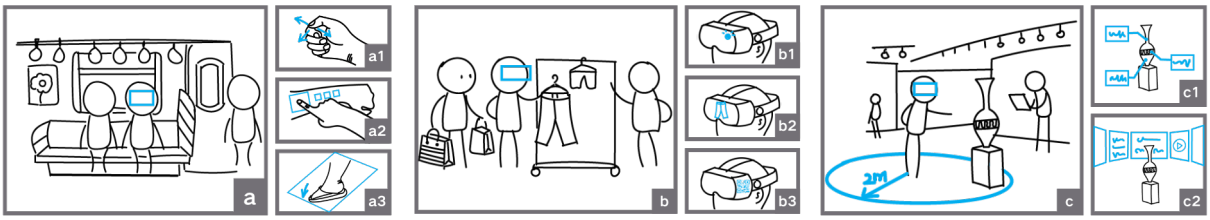

Figure 1: Illustration of three ambiguous social situations with users of cross reality devices and bystanders: (a) using implicit interactions around the (a1) hand (a2) forearm and (a3) feet on the subway to avoid being noticed; (b) visual cues such as (b1) a blinking light and (b2) an outward-facing screen to signify actions in a shopping mall; using (b3) a QR code for information and activity sharing; (c) enabling a focus mode when checking out (c1) artifact information and (c2) multimedia guide in a museum.

Abstract

We explore the use of Cross Reality (CR) technologies in ambiguous social situations, addressing the emotional responses of both users and bystanders. Through two preliminary studies, we examine the concept of vicarious awkwardness - how bystanders perceive and react to the actions of CR users. Our findings highlight the nuanced dynamics of social interactions in environments where the purpose of CR device usage is unclear. We argue that for CR to achieve broader acceptance, it is essential to design implicit interaction techniques and provide signifiers that facilitate understanding among bystanders regarding the intentions behind CR usage. By focusing on the subtleties of awkwardness and acceptability, this research aims to bridge the gap in current literature about the social implications of CR technologies. Ultimately, we advocate for strategies that enhance the social acceptability of CR, ensuring that both users and bystanders can navigate these interactions with greater ease and understanding. This work contributes to the ongoing dialogue about the integration of immersive technologies into everyday life towards the ubiquity of CR.

Index Terms: cross reality, social acceptability, awkwardness, vicarious awkwardness

1 Introduction

Cross Reality (CR) encompasses a spectrum of experiences across reality and virtuality, merging the physical and digital worlds for enhanced interaction and engagement. Multi-user CR interaction and collaboration is a rapidly growing field, enabling users to work together across real and virtual environments through diverse interaction techniques and interfaces with varying levels of virtuality. These multi-user CR experiences can enhance local, remote, and hybrid communication, foster creativity, and improve decision-making in domains such as design [17], training [4], and education [20]. Previous studies have focused on the users of enabling technologies, wearing a Head-Mounted Display (HMD) or holding a mobile device. However, the feelings and experiences of users at the other end of the spectrum, namely, the bystanders in reality, were rarely considered. This is nevertheless critical as CR devices become ubiquitous. Motivated by this research gap, we attempt to prioritize bystanders' attitudes and explore appropriate measures of their feelings when observing the use of CR devices and the associated social interactions. In particular, we examined *vicarious awkwardness*, a notable emotional response when emerging technologies are used in a number of situations without specified social norms, namely, ambiguous social situations.

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1.1 Awkwardness and Social Acceptability

Awkwardness is a direct consequence of our social nature and property of social interactions [13]. The feeling of awkwardness is an unwelcome emotion, yet it is inevitable and can sometimes play a significant role in social interactions. It is distinct from other emotional responses such as anxiety, embarrassment, or discomfort. Embarrassment is caused by a public failure to meet normative expectations [12], that is, a violation of social norms. Awkwardness occurs when the coordination scripts guiding social interactions are ambiguous or absent [13], explaining a category of phenomena that theories of embarrassment struggle with. Clegg [3] adopted a phenomenological approach to explaining the essence of awkwardness, suggesting that while this experience can lead to discomfort and social issues, it also fosters social progress, contributing to the evolution of societal behaviors and norms towards greater inclusivity, equity, and mutual understanding.

Awkwardness is often examined in previous studies that focused on social acceptability. Social acceptability refers to the degree to which new technologies and their interactions are perceived as appropriate. Profita et al. [14] studied bystanders' acceptance of on-body interface placement and gesture interaction at a given on-body location. Notably, they used attitudinal questions where participants chose two words from a set of adjectives to describe their attitudes toward the interaction and device position. The results showed that *'Normal'* and *'Awkward'* were two essential terms for capturing participant perceptions. In the study of the social acceptability of mobile VR glasses in public settings, Schwind et al. [15] considered awkwardness as one of the six key measures: awkward, normal, appropriate, rude, uncomfortable, and distracted. These

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studies indicate the important role of awkwardness in determining if a technology is socially acceptable.

For reality technologies in particular, Madier et al. [10] highlighted the necessity to reduce awkwardness and enhance the sense of togetherness in co-located VR experiences. The studies on social acceptability indicate that awkwardness should be mitigated for the use of technology to be acceptable. Therefore, obtaining an in-depth understanding of awkwardness will provide a complementary perspective that reveals the complexities and nuances of ambiguous social interactions regarding the adoption of new technologies.

1.2 Awkwardness in Ambiguous Social Situations

Feeling awkward is essentially social and unexpected. We use the term 'vicarious awkwardness' instead of 'vicarious embarrassment' to emphasize the social nature and unpredictable qualities of awkwardness other than violating social norms. Vicarious awkwardness is a type of awkwardness that results from witnessing embarrassing behaviors of strangers [1, 11]. This emotional response can be experienced by bystanders, even if the individuals involved in the awkward situation are unaware of any awkwardness [9]. Ahmet et al. [1] developed the Vicarious Embarrassment Scale (VES) and demonstrated that vicarious awkwardness is distinct from empathy. The experiment was conducted in a lab setting showing participants with video clips of depicted awkward moments in real-life situations or poor performances from TV shows. Building on Ahmet et al.'s work, Yohanes et al. [18] considered the impact of cultural factors and explored how the closeness of the relationship between the bystander and the protagonist significantly affects the experience of vicarious awkwardness in collectivist cultures.

These findings underscore the importance of understanding vicarious awkwardness in various social and cultural situations. However, we note that in most HCI studies, bystanders' attitudes tended to be studied in *explicit* contexts, where users and bystanders know each other and understand the purpose of interactions. Few studies investigated the *implicit* social interactions with total strangers in public settings. These contexts are known as `social ambiguous situations`, where the intentions and effects of users' interactions are ambiguous, and the relationship between the device users and the non-device-using bystanders is similar to that of strangers.

1.3 Towards the Ubiquity of Cross Reality

Cross reality devices and their interactions are likely to increasingly integrate into our society, as technologies mature and become more pervasive. This ubiquity will result in the use of wearable devices in more social ambiguous situations, consequently causing the experience of vicarious awkwardness among bystanders.

In recent years, researchers have examined the use of HMDs for explicit collaboration in social situations [6] and recognized the challenges encountered in the use of HMDs in shared and social spaces [5]. Various novel devices and interaction techniques are designed to address these issues, such as having an additional display mounted on the HMD [7] or having a public spectator view [2]. On one hand, improving these two aspects can indeed improve the experience for non-wearable users [19]. On the other hand, it may increase the physical and mental burden on the users themselves, such as leading to heavier headsets [7] or the disclosure of unintended private information [2]. We envision an ideal scenario where CR devices will become as ubiquitous as smartphones today. By that time, we will need to wear CR devices to complete daily tasks in ambiguous social situations instead of that of explicit collaboration. Current empirical studies on these situations are scarce and the understanding of the bystander perspective is limited.

In this position paper, we focus on the attitudes of bystanders toward the use of CR devices in ambiguous social situations. In particular, we are interested in two questions:

RQ1 Which one plays a more important role in the social acceptability of CR in ambiguous social situations: the form factors of the head-mounted display, or the actions performed?

RQ2 Towards the ubiquity of CR, what are the typical tasks in public or social situations, and what are the potential solutions to mitigate awkwardness?

We highlight the important role of awkwardness in social acceptability within such ambiguous contexts. Our first workshop helped reveal the vicarious awkwardness triggered by novel CR devices and interactions. A follow-up workshop was then conducted to explore the design factors affecting the ubiquity of CR concerning interactions in ambiguous social situations. By studying vicarious awkwardness, we hope to reveal the complexities and nuances of interactions involving CR devices, thereby guiding social coordination involving these technologies. We discuss some potential design solutions that address vicarious awkwardness.

2 Workshop 1: Cross Reality Co-creation Performance

As a part of the International Conference on Live Coding 2024, we hosted a cross-reality performance workshop on live coding, mapping users' body movements with real-time visual and sound effects in a CR experience [8]. For each performance, we invited a group of three audiences to wear HMDs, engage in free body movements, and collaboratively co-create the live-coding performance. The device utilized was the Holokit X[1], an optical see-through AR headset with an iPhone inserted, supporting 60° field of view and 6 degrees of freedom spatial tracking using ARKit. The visual and sound effects were affected by the actions they performed, such as the speed they moved and turned, the distance of the headset to the ground, the sound they made, and their proximity to each other. Users collectively create real-time music through their collaborative body movements, guided by the programmed affordance settings from live coders. In the meantime, the rest of the audience are bystanders, observing the trio performance and an augmented spectator view through a mobile display (see Figure 2). The event was held in an ample space for people to move around.

2.1 Data Collection

We informed the audience of the video recordings and data collection involved in the workshop. Participants first watched a performance by three actors wearing the headset to understand the play. They were invited to try the HMDs and join the performance. In total, we had six groups of three users that joined the co-creation performance. After the experience, we invited them to join a debriefing discussion and fill in a questionnaire about the social acceptability of the CR performance. In total, we had over 30 participants who joined the workshop, among which twenty participants (11 males, 9 females) filled in the post-experience questionnaire, aged from 18 to 45 years ($M = 22.93, SD = 2.35$). Eighteen participants were unfamiliar with anyone else in the workshop, while two of the participants were friends. Most of them had joined the CR performance and observed others' performances. This study was approved by our university ethics committee.

The questionnaire we used was adapted from Schwind's work [15]. Participants assessed the feeling when '*wearing the head-mounted display*' and *'performing the actions'* from six dimensions, including awkward, normal, appropriate, rude, uncomfortable, and distracted (see Appendix for full details). The actions performed in the workshop are mostly improvised by participants, including walking, turning, jumping, squatting, waving hands, making sounds, etc. The questions were mandatory and rated on a seven-point Likert scale (7 = strongly agree). Demographic data were collected at the end of the survey.

[1] https://holokit.io/products/holokit-x

Figure 2: (a) Three users co-creating a performance seen by a spectator view. (b-d) Screenshots of spectator views: ropes, springs, and magnetic field.

2.2 Results

We examined the Shapiro-Wilk test for the data distribution. The results showed that the data distribution was not normal. Therefore, we conducted a comparative analysis using Wilcoxon signed-rank tests to identify the differences in the six distinct dimensions of social acceptability between HMD devices and user interactions. The results showed that participants found the HMD and the actions performed appropriate, not rude or uncomfortable. However, they somehow felt slightly awkward, abnormal, and distracted. Comparing the form factors and the actions performed, participants rated significantly greater awkwardness for the actions performed than the headset worn (see Table 1). For the other dimensions, no significant difference was observed. Despite that the performance workshop took place in an informed context and most people were familiar with the CR technology and HMDs, vicarious awkwardness was inevitably perceived, particularly for the actions performed.

Table 1: Results of the social acceptability for the form factor of the HMD and the actions performed.

		Min	Mdn	Max	Mean	*SD*	*Z*	*p*
Awkward	HMD	1.0	2.0	6.0	2.65	1.46	1.99	**0.046***
	Action	1.0	3.0	6.0	3.4	1.70		
Normal	HMD	1.0	4.0	7.0	4.3	1.56	0.05	0.958
	Action	1.0	4.5	7.0	4.25	1.68		
Appropriate	HMD	3.0	6.0	7.0	6.1	1.17	0.58	0.564
	Action	4.0	6.0	7.0	6.0	1.03		
Rude	HMD	1.0	1.0	5.0	1.6	1.05	1.47	0.141
	Action	1.0	1.0	2.0	1.3	0.47		
Uncomfortable	HMD	1.0	1.5	5.0	1.7	0.98	0.53	0.598
	Action	1.0	1.0	5.0	1.9	1.33		
Distracted	HMD	3.0	6.0	7.0	5.4	0.94	1.51	0.132
	Action	3.0	6.0	7.0	5.65	0.99		

3 Workshop 2: Mitigating Awkwardness in Cross Reality

The review of related work and the results of the previous workshop indicated the important role of awkwardness in creating a socially acceptable CR experience. In particular, the actions performed appeared to play a more important role than the form factor of the HMD itself. Therefore, we conducted a follow-up workshop, aiming to brainstorm approaches to mitigating awkwardness in CR. The workshop involved two sessions. One was conducted with 5 experts (P1-P5), comprising 1 lecturer and 4 graduates (2 males, 3 females) aged between 25 and 42 ($M = 29.2, SD = 7.23$). The other one was conducted with 6 novices (P6-P11), all undergraduates (5 males, 1 female), aged from 19 to 20 ($M = 19.5, SD = 0.55$). Each session lasted for 1.5 hours. Members of the expert group are experienced in interaction design and have experience with CR development, so they have relevant knowledge to generate diverse ideas within the limited time frame of the workshop session. The novice session aimed to complement the results from different perspectives.

3.1 Procedure

At the beginning of the workshop, we provided participants with a brief overview of our research focus on vicarious awkwardness and the findings from the previous performance workshop. We then asked them to brainstorm a near-future scenario (in 5-10 years) when CR could be as ubiquitous as smartphones today. Specifically, we encouraged participants to 1) name a typical task they will do in a public or social situation, 2) describe the form factors of the CR device in use, and 3) perform the corresponding actions. After this, we probed questions about awkwardness: 1) Did you feel awkward when others were performing actions? 2) Can you come up with any means to make you feel less awkward?

3.2 Results

Several typical situations and tasks have been discussed in the workshop, mentioning the expected form factors shown in Figure 3. We summarize three examples in Table 2. Overall, participants tend to mitigate awkwardness by reaching two extremes: being implicit with unnoticeable actions, or being explicit with signified actions. In the meantime, a focus mode was suggested for situations being somewhere in between.

Figure 3: Typical form factors of CR devices: (a) a headset with no eye contact, e.g., Meta Quest 3; (b) a headset with simulated social cues, e.g., Apple Vision Pro; (c) a headset with transparent lenses, e.g., Microsoft HoloLens; (d) sunglasses, e.g., Nreal Air (e) glasses, e.g., Google Glass; (f) contact lenses.

Table 2: Example situations and corresponding tasks. The expected form factors are corresponding to those described in Figure 3.

Situation	Tasks	Expected Form Factors
Subway	Messaging (text entry)	D, E, F
	Watching videos	D, E, F
	Playing games	A, B, C, D, E, F
Shopping mall	Indoor navigation	D, E, F
	Virtual try-on	D, E, F
	Browsing restaurants	D, E, F
Museum	Accessing multimedia guide	A, B, C, D, E, F
	Making annotations	A, B, C, D, E, F

Be implicit: actions within arm's reach. Participants generally preferred implicit interaction actions for everyday tasks, such as messaging and watching videos. Aside from controller interactions that are agreeable to most participants, P3 suggested sliding the thumb along the fingers for selection tasks and text entry; P4 suggested an on-body menu on the forearm. Alternatively, P11 proposed to implement a phone-like interface to control digital objects; P2 mentioned that feet-based interactions can be implicit while seated. Voice control was considered suitable for scenarios with only a few people present at a distance. Also, P12 mentioned that the brain-computer interface can be the ultimate solution in the future. Participants were against interactions that extend beyond arm's reach while seated in ambiguous social situations (e.g., the subway). Essentially, participants indicated that they would feel less awkward if they were unaware of the actions taking place.

Be explicit: signifying actions using visual cues. While implicit interactions were greatly favored, some expressed curiosity about the HMD user actions in a public space (e.g., on the street or in shopping malls). Consequently, participants highlighted the need for some actions to be signified. The spectator view is a typical approach to achieve this (see Figure 2). Aside from visualizing the digital content, various visual cues were suggested, such as using blinking lights or an outward-facing screen with messages to signify the status of use (e.g., camera on/off). Participants also suggested the use of QR code for sharing information and activities. The key was to signify actions that would concern bystanders while allowing users the freedom to selectively disclose aspects of the virtual content. Despite the need for visual cues, some participants mentioned that the simulated eyes provided by Vision Pro made them feel uncomfortable and *'creepy'*, suggesting that information can be effectively communicated without the need for hyper-realistic representations.

Out of sight, out of mind: enabling a focus mode. P3 suggested that for some interactions, it is difficult to be implicit while being precise and natural, such as the direct selection and manipulation of a 1:1 scale virtual artifact in a museum setting. In such situations, P2 and P3 expressed willingness to *'expand the range of movements to achieve the goal.'* P1 suggested that a focus mode could be enabled to block views beyond a distance (e.g., 2 meters) to help alleviate any awkwardness from being aware of others nearby. In addition, for headsets with transparent lenses, they proposed shading them to prevent eye contact with others.

4 Discussion and Future Work

Our first workshop showed that awkwardness is an important aspect of social acceptability and the feeling of awkwardness appeared to be noticeable, even in an informed performance setting. This is consistent with the findings in the previous work [14]. Our findings further contribute to the understanding that the actions performed could result in elevated awkwardness compared to the HMD itself. This is partly because the input using body movements was not implicit, and the performance nature has encouraged participants to engage in body movements. Still, the results motivated us to reflect on the varying and fast-changing form factors of HMDs and to rethink whether the social acceptability of CR is affected more by the appearance of headsets or how they are used.

4.1 Acceptable CR Form Factors

Discussions in the second workshop revealed that despite the various form factors, participants recognized CR devices as two main types: headsets (A-C) and glasses (D-F) (see Figure 3). Participants found it acceptable to wear devices of various form factors in public or social situations, provided that they are ubiquitous. While we suspect this perspective may stem from the expert group familiar with using CR devices, users in the novice group seemed to share similar sentiments. This phenomenon can be understood through the herd effect [16] - when more individuals wear these devices in public, it normalizes the behavior and diminishes any associated stigma. Yet, some specific findings were found related to the situations. Participants valued immersion in games, so they would accept headsets without real-world eye contact. In busy scenarios like shopping malls, they preferred glass-shaped devices with transparent lenses. In situations where tasks are clear to bystanders (e.g., museums), participants had fewer concerns about the form factors. In particular, some participants noted that they would not bother to use A-C if they offered better precision in control than D-F.

4.2 Acceptable CR Interactions

Extensive discussion took place regarding the use of headsets, emphasizing the importance of implicit interaction techniques and clear indicators of actions in public and social settings. It was agreed that the use of technology would be less awkward if the actions performed were unnoticeable, and if the purpose or status of use for the noticeable actions were made explicit. Some previous works endeavored to mirror and share the HMD views with the spectators [6, 2]. We show that aside from directly visualizing the effects of interactions, abstract visual cues showing the purpose and status of use can serve as effective alternatives in ambiguous social situations. These cues do not need to be hyper-realistic. Concerns about cross-cultural differences were also raised, such as the fact that pointing with an index finger can be offensive in Chinese culture. In some cases, participants appeared to be self-focused, overlooking whether the use of CR devices was acceptable to others.

4.3 Measuring Awkwardness for Acceptability

As CR becomes more widespread, we are facing various ambiguous social situations where its use may not seem normal, especially when the devices are visibly worn on the head. In these cases, we argue that vicarious awkwardness can serve as a measurement tool to assess the acceptability of interactive technologies. This is an especially valuable indicator for interaction designers to consider, as it can clarify the subtle distinctions between the form factors of CR devices and their associated interactions. Nevertheless, the experience of awkwardness can be difficult to gather and measure, as it is subjective and non-verbal, usually an instant feeling that would occur in a specific context, and affected by various social norms. While surveys and observations could provide insights, such post-experience self-reported and interpretive ways are subject to bias. Future studies should assess awkwardness in the wild with effective objective measures to better facilitate the understanding of social dynamics of CR use, such as physiological measures (e.g., heart rate, galvanic skin response) and behavioral indicators (e.g., eye contact avoidance). Additionally, it would be interesting to explore if awkwardness persists as time changes.

4.4 Effectiveness of Solutions

In further study, we will assess the effectiveness of the solutions with the combination of different CR devices and social situations. Additionally, we aim to uncover valuable insights into when and how certain interactions unexpectedly fail or result in awkwardness. While our current study has a relatively small sample size, we plan to recruit more participants in future research to validate the method's effectiveness and generalizability. In the meantime, the increasing ubiquity of CR technologies raises potential ethical concerns, particularly related to privacy, consent, and the potential for misuse. The ethical implications should be carefully considered when implementing the interventions to mitigate awkwardness and make CR interactions more socially acceptable.

5 Conclusion

In this position paper, we present two preliminary studies that examined the vicarious awkwardness perceived by bystanders observing CR interactions. We show the important role that awkwardness and vicarious awkwardness play in ambiguous social situations, where CR users and bystanders may not know each other or comprehend the intent behind their actions. Our goal is to address the research gap regarding this specific emotional response, which is likely to be felt not only by the users but also by the bystanders. Through the first workshop, we learned that CR devices and interactions can elicit awkwardness even in an informed context, and we found the perceived awkwardness differed for the wearing of the HMD and actions performed. In the following workshop, we summarized the form factors of CR devices and the interaction actions user would perform to mitigate awkwardness. The results provide insights for the future design of CR interactions in ambiguous social situations. We contend that for CR to gain broader acceptance and be effectively utilized in real-world settings, future efforts should focus on developing implicit interaction techniques for everyday tasks and enhancing bystanders' comprehension of the purpose and status of CR device usage.

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Appendix

Q1 It looked **awkward** when this person was *wearing the head-mounted display*.
Q2 It looked **awkward** when this person was *performing the actions*.
Q3 It looked **normal** when this person was *wearing the head-mounted display*.
Q4 It looked **normal** when this person was *performing the actions*.
Q5 It looked **appropriate** when this person was *wearing the head-mounted display*.
Q6 It looked **appropriate** when this person was *performing the actions*.
Q7 It looked **rude** when this person was *wearing the head-mounted display*.
Q8 It looked **rude** when this person was *performing the actions*.
Q9 It looked **uncomfortable** when this person *wearing the head-mounted display*.
Q10 It looked **uncomfortable** when this person was *performing the actions*.
Q11 I would be **distracted** by this person *wearing the head-mounted display* if we were together in a public space.
Q12 I would be **distracted** by this person *performing the actions* if we were together in a public space.