"When We're Looking at the Robot, We See Each Other": A Comparison of Robotic, Mirror-Based, and Hybrid Interventions for Stranger Interaction

Serena Ge Guo
Information School
University of Wisconsin-Madison
Madison, Wisconsin, USA
gguo28@wisc.edu

Qi Yang
Design Studies
University of Wisconsin-Madison
Madison, Wisconsin, USA
qyang347@wisc.edu

Jenny J Yu
Cornell University
Ithaca, New York, USA
jy865@cornell.edu

Wenqian Niu
Cornell University
Ithaca, New York, USA
wn85@cornell.edu

Yunting Yan
Mechanical Engineering
Cornell University
Ithaca, New York, USA
yy2244@cornell.edu

Guy Hoffman
Cornell University
Ithaca, New York, USA
hoffman@cornell.edu

Gilly Leshed
Information Science
Cornell University
Ithaca, New York, USA
gl87@cornell.edu

Keith Evan Green
Human Centered Design; Mechanical & Aerospace Engineering
Cornell University
Ithaca, New York, USA
keg95@cornell.edu



Figure 1: A Robotic Mirror System Fostering Serendipitous Eye Contact

Abstract

Eye contact between strangers, even fleeting, can spark interaction and foster connection, happiness, and belonging. Yet in public spaces, such encounters are often suppressed by "civil inattention," with many people absorbed in their phones. We explore how reconfiguring the ambient environment with *MirrorBot*, a mobile robot with adaptive mirrors, can encourage social encounters by subtly redirecting glances. By shifting reflections between self-

This work is licensed under a Creative Commons Attribution 4.0 International License.

CHI '26, Barcelona, Spain

© 2026 Copyright held by the owner/author(s).

ACM ISBN 979-8-4007-2278-3/26/04
https://doi.org/10.1145/3772318.3791832

and mutual recognition, *MirrorBot* invites serendipitous eye contact, shared awareness, and low-stakes engagement. In a controlled 2×2 between-subjects study with 90 participants (45 dyads) across four conditions (*MirrorBot*, Bot-only, Mirror-only, and Control), we found that *MirrorBot* led participants to initiate conversation more often, feel greater closeness and togetherness, and have more enjoyable interactions. Our findings position robots not only as social agents but as socio-spatial interfaces that choreograph sight lines and shared attention in physical space, opening new possibilities for technologies that cultivate human connection in public life.

CCS Concepts

• **Human-centered computing → Ubiquitous and mobile computing systems and tools**.

Keywords

Social Robot, Embodied Social Interaction, Human-Human Interaction, Strangers, Public Space, Mirror, Socio-Spatial Interface

ACM Reference Format:

Serena Ge Guo, Qi Yang, Jenny J Yu, Wenqian Niu, Yunting Yan, Guy Hoffman, Gilly Leshed, and Keith Evan Green. 2026. "When We're Looking at the Robot, We See Each Other": A Comparison of Robotic, Mirror-Based, and Hybrid Interventions for Stranger Interaction. In *Proceedings of the 2026 CHI Conference on Human Factors in Computing Systems (CHI '26), April 13–17, 2026, Barcelona, Spain.* ACM, New York, NY, USA, 34 pages. https://doi.org/10.1145/3772318.3791832

1 Introduction

Eye contact, often regarded as the foundation of human connection, serves as a powerful initiator of social interactions between strangers [33]. From a fleeting glance across a crowded room to a brief smile exchanged on a bustling street, eye contact establishes a momentary sense of mutual recognition that can, at times, become the seed of deeper relationships. A growing body of work shows that even brief, low-stakes encounters with strangers, such as saying hello, sharing a joke, or exchanging a few sentences, can enhance happiness, belonging, and perceived social cohesion [90, 98]. At the same time, people reliably underestimate how positive these interactions will feel and overestimate how awkward or unwelcome they will be, leading them to forgo potentially nourishing moments of contact in everyday life [89].

In contemporary public spaces, these small openings for connection are further constrained by what Goffman called "civil inattention" [31]: we acknowledge others' presence while carefully avoiding any act that might be read as intrusive. In airports, waiting rooms, and campus lounges, many people are absorbed in their phones or laptops —not simply because they prefer isolation, but because the social cost of "making the first move" with a stranger feels ambiguous and risky. Designing tools that expand the repertoire of how people can acknowledge and lightly connect with one another in public, while preserving the right to opt out, is thus a meaningful problem for HCI and HRI, not simply a matter of alleviating boredom or policing phone use.

Within this broader landscape, shared eye contact is a particularly consequential social signal. Direct gaze can signal interest, friendliness, or the wish to coordinate [3, 92]; but can also feel confrontational or unsafe, especially between strangers [1, 99]. This raises a key question for interaction design: How might we design mediated gaze, such as reflections, alignments, and choreographed lines of sight, that gently create opportunities for strangers to notice each other, test one another's social readiness, and, if they choose, transition from shared looking into brief verbal interaction?

Prior work in HCI and HRI has begun to address related aspects of mediated gaze and social signaling, but leaves important gaps. Some systems directly manipulate where and how people look at each other, using mediated gaze to open shared encounters (e.g., eye-contact prompts or gaze-aware robots) [7, 71, 86, 95]. Beyond gaze, systems such as shape-changing benches [53], rotating barstools [87], and interactive stools [35] subtly reconfigure seating and proxemics to nudge strangers into bodily proximity and potential eye contact, lowering the barrier for serendipitous encounters. Other interventions use playful or performative cues, such as jokes, sound, or exaggerated motion, to draw attention and provide a conversational opening [7, 17, 59, 102]. However, we still know little about how the built environment itself—through mobile, reflective objects—might be used to mediate gaze between two co-present strangers. This motivates us to explore a robotic mirror system for this purpose.

Mirrors have long held both symbolic and functional roles across cultures. Beyond serving as tools for image reflection, they have been used in art [78, 91], architecture [74], literature [21, 80], and theater [68, 73] to explore how people see themselves in relation to others [57, 63], manipulate perspective, and reveal layered social dynamics (e.g., Manet's Bar at the Folies-Bergère, Svoboda's mirrored scenography). This long history positions mirrors as a particularly evocative medium for probing self/other perception and shared attention. More recently, interactive mirrors have been employed in human–computer interaction in diverse contexts, such as performance [48], digital augmentation [65, 97], and remote communication [86]. However, these implementations rarely consider how robotic mirrors can mediate social interactions between individuals in shared physical spaces. In other words, we lack a systematic understanding of mirrors not just as surfaces for self-view or remote view, but as mobile, controllable artefacts that choreograph gaze and social signaling between strangers.

To address this gap, we introduce *MirrorBot*, an adaptive mirror system mounted on a mobile robot designed to create serendipitous, non-verbal interactions between strangers (Figure 1). By dynamically repositioning its mirrors within a space, *MirrorBot* creates structured opportunities for mediated eye contact and shared attention without demanding speech, allowing people to use *MirrorBot* as a low-risk "excuse" to look, smile, or eventually talk.

We examined how this form of mediated gaze shapes social signaling and connection, guided by the research question: *How do different combinations of robot and adaptive mirrors affect social connection outcomes between strangers?* We carried out a controlled 2-by-2 experiment with 90 participants in 45 dyads across four conditions that cross robot presence (yes/no) and mirror presence (yes/no): *MirrorBot* (robot + adaptive mirrors), *Bot-only* (robot without visible mirrors), *Mirror-only* (static mirror), and *Control* (no intervention). We compared how these configurations affect conversation initiation, interpersonal closeness, togetherness, and

perceived interaction quality between strangers. We found that with *MirrorBot*, participants initiated conversation more often, felt greater closeness and togetherness, and had more enjoyable interactions.

Our work makes three contributions. First, we introduce *MirrorBot*, a novel robot that leverages the symbolic and interactive affordances of mirrors to create opportunities for social connection in public settings. Second, we provide empirical evidence about the respective strengths and weaknesses of robot movement and mirrors in facilitating interaction between strangers. Third, we synthesize these insights by examining how *MirrorBot*'s design and deployment facilitate stranger interaction, situating mirrors as a social and playful material, and deriving design implications for ice-breaking technologies in shared spaces. Together, these contributions invite a broader rethinking of the roles social robots might play in public life—not as conversational partners, but as spatial mediators of human-to-human encounter.

2 Related Work

To situate *MirrorBot* in prior work, we synthesize three complementary threads. We first review technologies designed to facilitate serendipitous encounters in public space, then examine mirrors as cultural and interactive artefacts, and finally discuss how robots can mediate human–human interaction through non-verbal cues.

2.1 Designing Technologies for Serendipitous Encounters

Research in psychology has shown that even brief interactions with strangers can enhance social belonging and psychological well-being, underscoring the value of designing technologies that facilitate such moments [9, 34, 90, 98]. Within HCI and HRI, scholars have explored a range of interactive systems intended for deployment in public spaces to encourage serendipitous encounters.

One stream of work has focused on interactive furniture and objects that gently provoke strangers to acknowledge one another. The *CoMotion Bench* employed shape-changing interfaces that altered the seating configuration to nudge strangers into eye contact and bodily proximity, thereby lowering the barrier for spontaneous encounters [53]. Sadka et al.'s robotic bar stools rotated toward each other when occupied, reorienting sitters into face-to-face positions and transforming solitary sitting into an opening for social interaction [87]. Similarly, *SocialStools* embedded proxemics-based projections into stools to encourage reorientation of posture and body angle, lowering the threshold for initiating interaction [35]. These projects illustrate how everyday objects, when actuated, can subtly reconfigure proxemics to catalyze new forms of engagement.

Other systems have explored playful, performative cues as social catalysts. Balestrini et al.'s *Jokebox* broadcast humorous audio clips when people made eye contact, using laughter as a shared affective resource that encouraged conversation among strangers [7]. Likewise, Brown et al. deployed a robotic trashcan in a public square that interacted with passersby through movement, creating opportunities for unexpected micro-encounters in everyday routines [17]. In the *BubbleBot* project, a speculative robotic entity floated in the periphery of public space to nudge spontaneous human interactions through its presence and movement design [59]. Zhang et al. demonstrated that both robots and computer-mediated prompts could foster meaningful first conversations between strangers, showing how technology can lower social barriers and seed authentic connections [102]. These examples highlight how interactive agents in public contexts can capture attention, spark curiosity, and transform mundane moments into shared social experiences among strangers.

These interventions underscore both the potential and the challenges of ambient systems designed for serendipity. On one hand, they can effectively reduce the psychological barriers of civil inattention by providing playful excuses for strangers to acknowledge one another. On the other hand, they must carefully balance intrusiveness: overly directive interventions risk being disruptive or coercive, while too subtle ones may fail to register socially. *MirrorBot* builds on this lineage by applying an everyday, non-anthropomorphic medium—mirrors—to mediate eye contact between strangers. Rather than demanding verbal participation or positioning the robot as the focus of interaction, *MirrorBot* uses mirrors that facilitate eye contact to redirect attention toward the other person and frame mutual recognition as a shared, low-risk discovery. It contributes a novel approach to designing for serendipity: creating conditions for spontaneous eye contact that can possibly unfold into smiles, nods, or short exchanges, supporting momentary connections.

2.2 Mirrors as Cultural, Symbolic, and Interactive Artefacts

In art and literature, mirrors have been used to interrogate selfhood and perspective, challenging the boundary between self and world. For example, *Bar at the Folies-Bergère* by Édouard Manet employs mirrors to layer multiple perspectives of the same scene, reflecting social interactions in ways that unsettle the viewer's sense of spatial and relational orientation [79]. Similarly, mirror installations in modern and contemporary art have used reflective surfaces to multiply perspectives, fragment identity, and provoke shifts in self-perception [78, 91]. Lewis Carroll's *Through the Looking-Glass* stages the mirror as a portal into an inverted, fantastical universe where familiar logics are destabilized [21]. Sylvia Plath's poem *Crossing the Water* similarly invokes mirrors to evoke self-confrontation and emotional disorientation, reflecting psychological complexity through distorted imagery [80].

In spatial experiences such as those created by architecture and theater, mirrors have been applied to manipulate the experience of space and social presence. For example, the reflective canopy installed at Marseille's Vieux Port, for instance, transforms the plaza by visually doubling crowds and everyday activities, inviting passersby to see themselves and others as part of a larger shared social scene [74]. Such projects highlight how mirrors alter both perception and social dynamics by embedding self-reflection into the fabric of public space. Scenographer Josef Svoboda used large-scale mirror surfaces to distort perceptions of time, space, and self, enabling audiences to perceive both performers and themselves within altered theatrical realities [68, 73]. These scenographic experiments exemplify how mirrors can redistribute attention and reconfigure the social relationship between spectators and actors.

More recently, HCI researchers have incorporated interactive mirrors into technological design. Mirrors have been used in performance contexts to augment bodies with digital overlays and responsive projections [48], in augmented reality systems to merge virtual and physical imagery [65, 97], and in remote communication systems to simulate co-presence through reflected gaze [86]. While these implementations demonstrate the versatility of mirrors as interactive artefacts, they rarely consider how mirrors might directly mediate social interactions between co-present individuals. *MirrorBot* addresses this gap by using mirrors not as self-facing devices, but as relational mediators that redirect gaze to foster connection between strangers.

2.3 Robotic Non-verbal Mediation of Social Interaction

Non-verbal behaviors such as gaze, body orientation, and gesture are critical in shaping the flow and quality of social interactions, and prior HRI research has explored how robots can leverage these cues to scaffold interpersonal dynamics. Early work demonstrated that robotic gaze and orientation can regulate turn-taking, enabling smoother conversational exchanges among humans by directing attention and coordinating speaking order [71]. Similarly, Jung et al. showed that robots can intervene in group settings to regulate conflict, using movement and positioning as subtle cues to de-escalate tension and facilitate more constructive collaboration [49]. Robots have also been designed to evoke empathy or prosocial attitudes by embodying vulnerable or expressive non-verbal signals, such as Hoffman et al.'s work on socially evocative robotic motion [43]. Similarly, Szafir and Mutlu demonstrated that subtle variations in robot gaze and orientation influenced trust and coordination in collaborative tasks [95].

More recent studies have focused explicitly on how non-verbal robot behaviors can influence stranger interactions. Rifinski et al. demonstrated that minimal socially responsive gestures such as gaze shifts and leaning motions from a simple tabletop robot could positively impact interpersonal evaluations between two individuals engaged in debate, improving perceived warmth and reducing adversarial framing [84]. Press et al. explored how robotic objects performing humorous non-verbal behaviors—combining unexpected fast and slow movements—helped reduce awkwardness and created a shared sense of play between strangers meeting for the first time [81]. Similarly, Tennent et al.'s Micbot used subtle back-channeling motions, such as nodding or tilting, to encourage team members to speak, showing that even when embodied in a mundane object like a microphone, non-verbal robot behaviors can enhance group engagement and performance [96].

These studies underscore the power of non-verbal robotic behavior to act as a mediator for social interactions. By shaping gaze, proxemics, and motion cues, robots can facilitate smoother turn-taking, reduce social awkwardness, and foster engagement between strangers. *MirrorBot* extends this line of inquiry by introducing a novel non-verbal mediation strategy: redirecting gaze through interactive mirrors. Instead of directly gesturing or orienting toward individuals, *MirrorBot* creates mediated eye contact between them, illustrating how non-verbal robotic cues can be externalized through familiar objects to spark new forms of social connection.

3 MirrorBot Design

MirrorBot is a mobile robot with two mirrors with 2 degrees of freedom (Figure 1) that adjust to foster serendipitous eye contact [37, 39]. In this section, we present the design of interaction, robot forms, intervention scenarios, and technical implementation.

3.1 Mirror Design and Prototyping Process

The idea of using mirrors as the core medium of *MirrorBot* emerged from a design inquiry into how self–other perception is shaped in everyday spaces. Drawing on prior work that uses mirrors to manipulate perspective and layered social dynamics in art, architecture, theater, and interactive systems [48, 68, 74, 86], we were intrigued by mirrors as familiar, culturally legible objects that can redirect gaze without introducing new symbols or speech into the environment. In early concept sketches and storyboards, we imagined public settings where a moving mirror could subtly "reframe" how two strangers see each other, allowing them to first encounter one another through reflection before committing to direct eye contact. This conceptual question motivated us to commit to mirrors as the primary material and to explore how their spatial arrangement and motion might choreograph different forms of mediated gaze.

Guided by this idea, we developed sketches and low-fidelity prototypes to explore the design space for mediating spontaneous eye contact between strangers using mirrors. These iterative explorations focused on how different spatial arrangements of mirrors could influence the ways individuals direct and redirect their gaze toward others.

As shown in Figure 2, our key explorations included: mirrors facilitating mutual eye contact between individuals sitting back-to-back (Figure 2-a), a large mirror embedded with a smaller one to blend reflections of the self and the other (Figure 2-b), and two mirrors opening like a "book" to create balanced views of both individuals (Figure 2-c). We also experimented with intersecting mirror stripes to blur self-other boundaries (Figure 2-d), and dynamically placed mirrors in space to enable spontaneous and unpredictable visual connections (Figure 2-e).

Through informal trials, we found that the back-to-back layout lacked peripheral salience, the small-in-large mirror over-emphasized self-inspection, and the striped layout fragmented faces, making expressions hard to read. In contrast, the parallel, "book-like" layout offered clear mutual visibility, comfortable side-by-side proxemics, and a more balanced perception of self and other, leading us to adopt it as the basis for the design of *MirrorBot*. This layout provides clear, legible views of both self and other, supports comfortable side-by-side or slightly oblique positions, and allows *MirrorBot* to gradually bring strangers into mutual awareness rather than forcing abrupt, direct eye contact. We used simple circular mirrors, approximately the size of a human face at a distance of two meters, so people could clearly see each other's facial expressions, and the round shape conveyed a soft, approachable image of the robot [25].

3.2 Key States of Mirrors

We identified four key states in a two-person interaction scenario with *MirrorBot* (Figure 3):

In the **Voids** state (Figure 3-a), both individuals see only random environmental scenes in the mirrors. This occurs when *MirrorBot* is

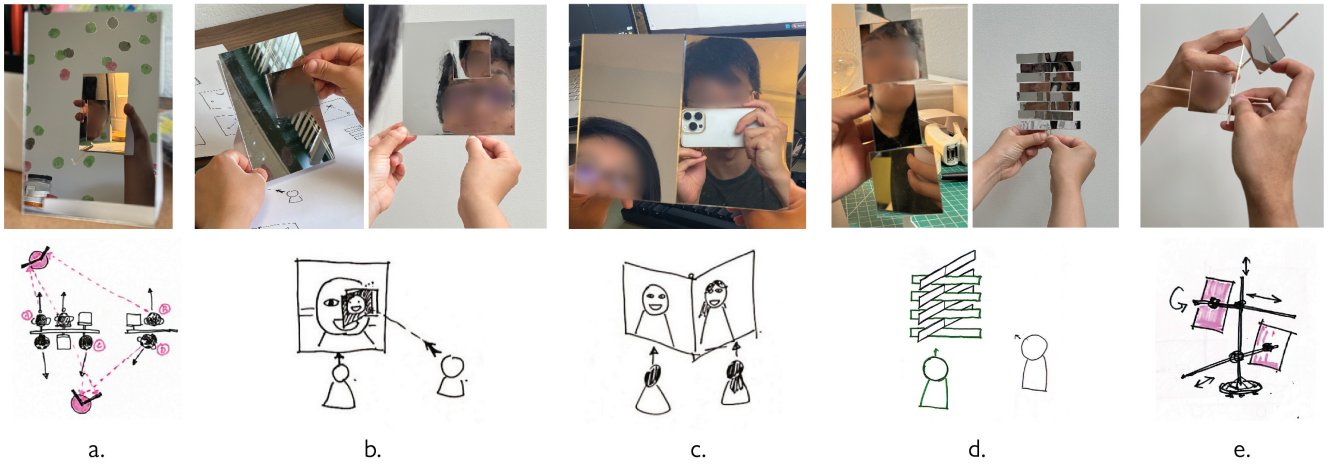


Figure 2: Design and prototyping process to explore how two mirrors facilitate different self-other perception: (a) Two mirrors reflecting each other in space: Facilitates mutual eye contact for individuals sitting back-to-back. (b) One large mirror with a smaller mirror embedded inside: Allows individuals to primarily see themselves, with parts of their face blending into the reflection of another person. (c) Two mirrors opening like a "book": Creates an equal view for both individuals as the mirrors gradually open. (d) Two mirror stripes intersecting: Blurs the images of self and other, blending their reflections together. (e) Two mirrors appearing randomly in space: Facilitates unexpected and surprising encounters.

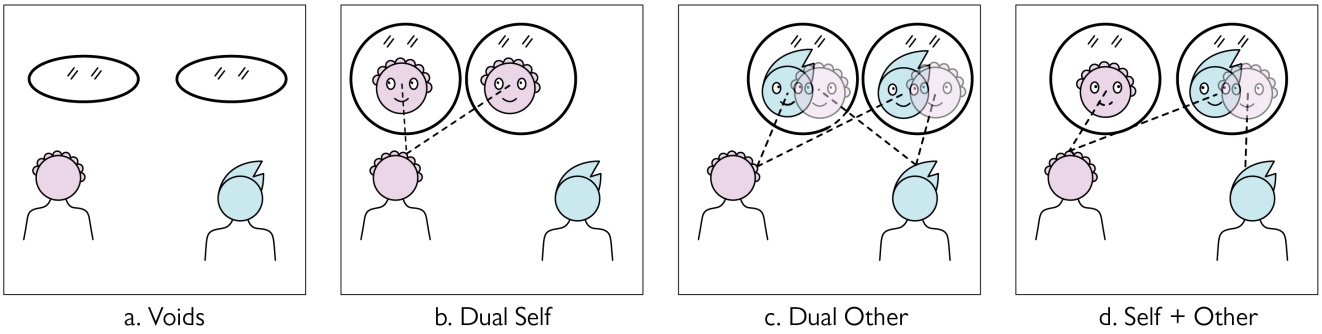


Figure 3: The four key states of two mirrors: (a) Voids, (b) Dual Self, (c) Dual Other, and (d) Self + Other

navigating or using subtle mirror movements—nodding, swinging, or fidgeting—to attract attention.

In the **Dual Self** state (Figure 3-b), one person sees their own reflection in both mirrors, while the other person sees random environmental scenes. This state will alternate for the two individuals, drawing attention to the mirrors as each person notices their own reflection.

In the **Dual Other** state (Figure 3-c), both individuals see each other in both mirrors simultaneously. This state facilitates awareness of the other person through eye contact.

In the **Self + Other** state (Figure 3-d), one individual sees their reflection in one mirror and the other individual's reflection in the second mirror. Simultaneously, the other person sees the first individual in one mirror and random environmental scenes in the other. This state integrates both self and other, alternating between the two individuals to ensure balanced experiences of eye contact.

3.3 Dynamic Interaction Scenario

The intended interaction scenario for *MirrorBot* is set in public spaces where individuals experience idle periods (e.g., airport terminals, coffee shops, waiting rooms, or student lounges). In these settings, people are physically present but often socially disengaged, absorbed in individual activities like being on their phones. *MirrorBot* seeks to transform these solitary moments into opportunities for subtle, playful social connection through its adaptive mirrors.

Figure 4 shows the dynamic interaction scenario unfold throughout the interaction of two strangers. The scenario begins by *MirrorBot* identifying two strangers sitting apart from each other in the space (Figure 4-a). Once detected, the robot approaches them (4-b) and uses gentle mirror movements, such as "nodding" and "shaking," to attract their attention (4-c). Initially, the individuals alternatively notice their own reflections in the mirrors, which draws them into engaging with the robot (4-d). As curiosity builds,

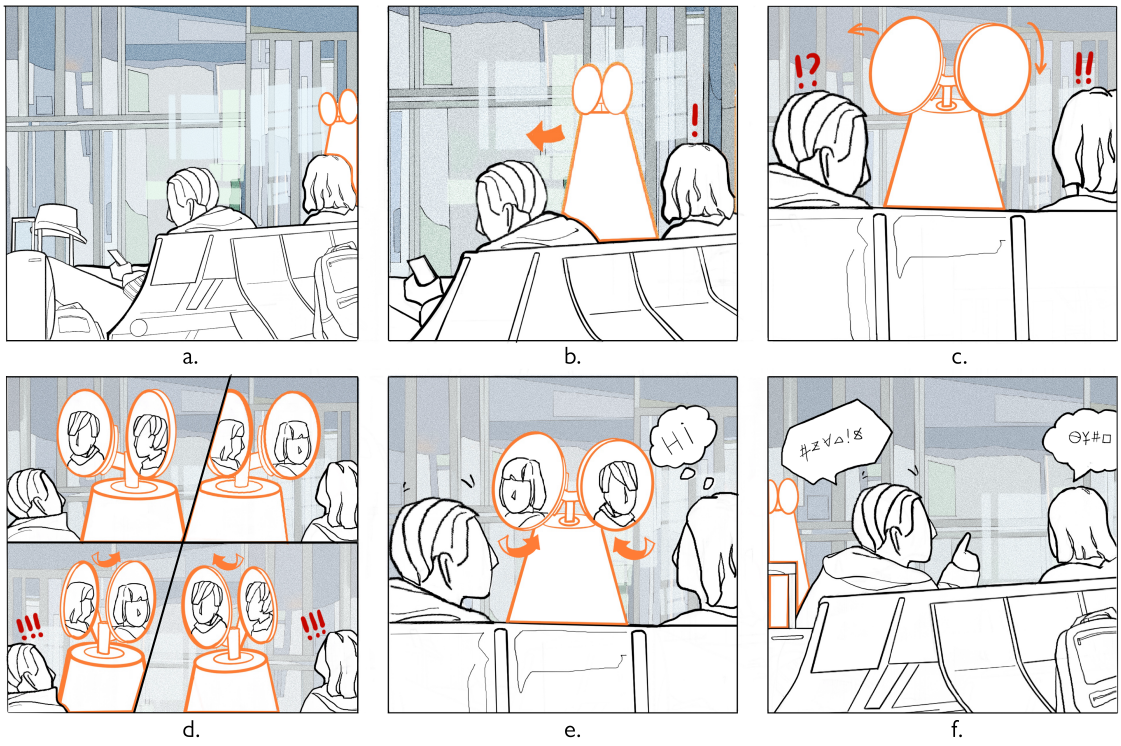


Figure 4: Dynamic Interactions Enabled by *MirrorBot*: (a) Two strangers are absorbed in their phones in an airport terminal. (b) *MirrorBot* detects the two strangers and moves toward them. (c) *MirrorBot* uses "nodding" and "shaking" movements with its mirrors ("Voids" state) to attract the attention of the individuals. (d) The individuals first notice their own reflections in the mirrors ("Dual Self"), followed by noticing the other's reflections in the mirrors ("Dual Other"). (e) The strangers view themselves in one mirror and the other person in the adjacent mirror, fostering a moment of shared awareness ("Self + Other"). (f) *MirrorBot* leaves when two strangers start talking with each other face-to-face, or show no intention to interact with one another.

the robot adjusts the mirrors to reveal the reflection of the other person (4-d). This transition subtly introduces mutual awareness, encouraging non-verbal interactions, such as a smile or nod.

As the interaction evolves, *MirrorBot* actuates its mirrors to allow each individual to see themselves in one mirror and the other person in the adjacent mirror (4-e). This creates a shared moment of connection, fostering opportunities for interpersonal engagement. The robot continuously monitors the social dynamics using its sensing system and algorithms. If the individuals begin interacting face-to-face directly through gestures, smiles, or conversation *MirrorBot* gracefully exits the scene. Similarly, if no sign of interest or engagement is detected, the robot departs to seek new opportunities for connection (4-f).

3.4 Form Design

MirrorBot is designed to evoke friendliness and minimize perceived threats. To achieve this, we reviewed prior studies on how form, body outline, and color influence human perception and emotion [60, 61]. Perceptions of robot design vary significantly due to individual differences, such as gender, cultural background, and context [61]. While human-like robots are often perceived as trustworthy and warm, they can evoke the "uncanny valley" effect if not designed carefully [70]. Similarly, animal-like robots may elicit positive responses but are subject to individual preferences [60]. Accordingly, we opted for a design that doesn't explicitly reference humans or animals to minimize prior assumptions and foster curiosity: *MirrorBot* (Figure 5) is A-shaped and rounded, 1.3 meters tall, which tends to be perceived as friendly, innovative, and non-threatening [6, 11, 25, 47, 61]. To enhance approachability, the robot's body is covered with yarn, concealing internal components like wiring, servos, and the laptop, thereby creating a soft and approachable appearance [82].

3.5 Technical Implementation

MirrorBot is structured as an aluminum spine and a hull made from medium-density MDF (Figure 5). The robot's hardware integrates components for sensing, actuation, and control. For sensing, it employs an Intel *RealSense* D455 RGB-D camera to support navigation, enabling it to perform SLAM based on visual-inertial odometry. The mobile base features an actuated 3-DOF design with omni-wheels, while four servos drive two 2-DOF platforms each supporting an

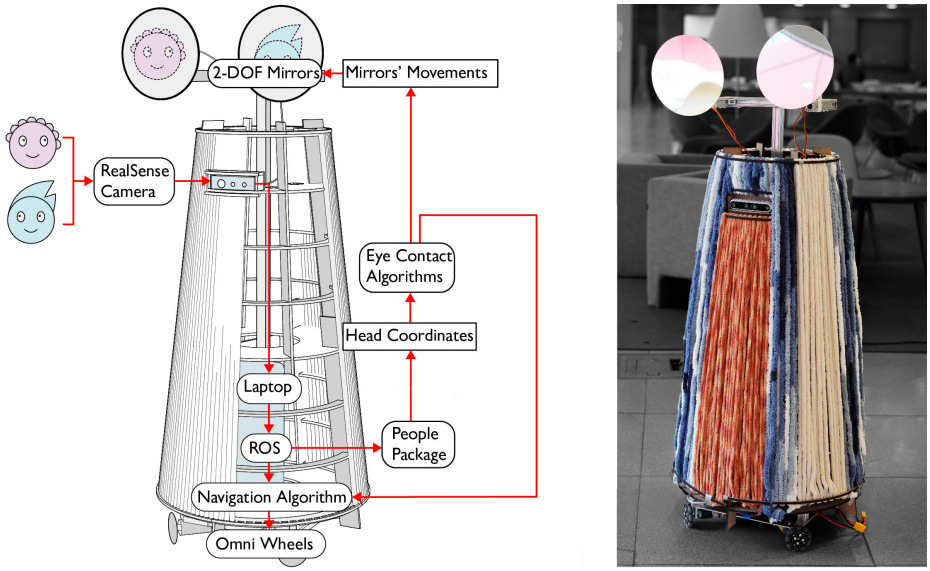


Figure 5: System diagram of *MirrorBot* (left) and the actual *MirrorBot* prototype (right).

8-inch round mirror. An onboard laptop serves as the central control unit for the robot's operations. The software includes a face-detection algorithm implemented using the *ROS-People* package. Detailed information about the training dataset or the evaluation of facial detection bias for the *ROS-People* package was not available to us [52]. To address this, we conducted a preliminary pilot test with researchers of different genders and skin tones, and the performance was acceptable. We developed algorithms to enable various eye-contact states, social-state detection, dynamic interactions, and navigation. In the pilot test, we found that *MirrorBot* connected people reliably when each participant was within approximately 2.5 meters of the robot, making it suitable for short-range settings such as waiting areas and lounges. Beyond this range, faces became too small in the 8-inch mirrors, so the current prototype is not intended for far-apart users or very crowded spaces with occluded sightlines.

4 Method

We conducted a between-subjects experiment with 45 pairs of participants (90 individuals in total), none of whom were previously acquainted. Participants were told they were taking part in a short-term memory challenge task, which served as a cover story to reduce potential bias. Each pair sat in a waiting room for 10 minutes under one of four conditions designed to test hypotheses about the effect of *MirrorBot* on the interaction dynamics between two people who meet for the first time. The study protocol was approved by the university's Institutional Review Board (IRB).

4.1 Hypotheses

Prior work on mutual gaze and joint attention shows that shared eye contact and a shared focal object can signal availability, reduce uncertainty, and support coordinated interaction [3, 92]. At the same time, co-experiencing a novel or playful stimulus, such as a surprising event or unusual artefact, can serve as an easy conversational "hook" that fosters interpersonal closeness and a sense of togetherness without requiring deep self-disclosure [22, 75]. *MirrorBot* is designed to combine these mechanisms: the moving robot provides a salient, shared focal point, while the adaptive mirrors structure opportunities for mediated eye contact and shared attention, which we expect to jointly amplify the social effects beyond a robot alone or a static mirror alone.

4.1.1 Initiating a Conversation. Initiating a conversation is a key threshold in stranger interaction, as ambiguity about whether and how to begin talking often hinders engagement [16, 19]. Conversation initiation therefore serves as a key indicator of whether *MirrorBot* does more than attract attention and actually helps strangers cross the threshold from silent co-presence into active engagement. Prior work shows that mutual gaze and joint attention to a shared object can act as powerful coordination devices for opening talk: when two people can mutually see that they are both attending to the same thing, it signals mutual availability, reduces uncertainty about approach, and provides an obvious first topic [3, 22, 92]. We therefore hypothesize that *MirrorBot* will lower this barrier by enhancing mutual eye contact through mirrors and by offering a shared focal point in the robot as a natural conversation cue.

H1. *MirrorBot* will make it easier to **initiate a conversation** with a stranger.

4.1.2 Interpersonal Closeness. In HRI and social computing research, interpersonal closeness is used to evaluate perceived connection with other humans [102]. Drawing on Social Penetration Theory [2], emotional closeness is a gradual outcome of reciprocal interaction. Co-experiencing a mildly novel, positive event and jointly attending to a third object can accelerate feelings of closeness by offering a safe, low-risk focus for self-disclosure and emotional commentary [5, 83]. Interpersonal closeness therefore serves as a key indicator of whether *MirrorBot* does more than just prompt



(a) *MirrorBot* condition **(b) *Bot-only* condition (same robot as in *MirrorBot*, but mirrors replaced with cardboard disks)** **(c) *Mirror-only* condition (static mirrors mounted on room partitions; no robot)** **(d) *Control* condition (no robot, no mirrors)**

Figure 6: Four Experimental Conditions

conversation by actually strengthening the perceived relationship between two previously unacquainted strangers. We hypothesize that *MirrorBot* will serve as a catalyst to fostering interpersonal closeness as people would share more emotions and interpersonal feelings with each other.

H2. *MirrorBot* will induce higher levels of perceived **interpersonal closeness** between strangers.

4.1.3 Togetherness. Drawing on concepts of co-presence [12] and togetherness [8, 45], the subjective experience of "being together" involves not only shared attention, but also a sense that one's actions are contingently noticed and met by the other person. Increased togetherness therefore indicates whether *MirrorBot* changes not just if people talk, but whether they experience themselves as sharing a situation and shaping it together, rather than simply sitting side-by-side in the same space. Prior work shows that people feel more "with" one another when they are jointly attending to, and jointly affected by, a responsive environment, not just co-located in space [12, 31]. In *MirrorBot*, the mirrors reposition based on the joint configuration of the two participants, so each person can see that both their own and the other's movements continuously reshape a shared visual field. We hypothesize that this jointly responsive visual field will support a subtle feeling of "being together"—attending to the same thing and jointly influencing what happens—beyond what a static mirror or a non-adaptive robot can provide.

H3. *MirrorBot* will induce stronger perceptions of **togetherness** between strangers.

4.1.4 Overall Interaction Experience. Studies of everyday encounters suggest that moments that feel surprising, playful, or slightly out of the ordinary are remembered as more engaging and enjoyable, especially when they are co-experienced with another person [13, 24, 90]. Interaction quality therefore captures whether *MirrorBot* transforms an otherwise routine waiting period into a conversational session that feels worthwhile, enjoyable, and energizing, rather than merely a way to pass the time. In our design, the moving mirrors create serendipitous, "out-of-the-ordinary" reflections that both people see at the same time, turning the robot into a shared, playful spectacle rather than just a moving object in the periphery. We therefore expect *MirrorBot* to more reliably evoke curiosity and delight among strangers, leading to a more engaging and memorable interaction.

H4. *MirrorBot* will offer a positive **overall interaction experience** among strangers.

4.2 Experiment Design

To test the hypotheses, we designed four experiment conditions in a 2-by-2 design: *MirrorBot*, *Bot-only*, *Mirror-only*, and *Control* (Figure 6). This design isolated two key factors: robot presence and mirror presence, to investigate how each contributes to shaping interactions between strangers.

- The *MirrorBot* condition introduced both a moving robot and mirrors (Figure 6-a).
- The *Bot-only* condition retained the robot's physical presence and movement but removed its reflective functionality by covering the mirrors, allowing us to examine the role of the robot's embodiment and motion alone (Figure 6-b).
- The *Mirror-only* condition introduced a static mirror placed in front of participants, allowing them to see each other's reflections but without movement or adaptive behavior (Figure 6-c).
- Finally, the *Control* condition served as a baseline, with no technological or environmental intervention (Figure 6-d).

We hypothesize that *MirrorBot* will enhance stranger interaction across all four outcomes of social interaction between strangers—conversation initiation (H1), interpersonal closeness (H2), togetherness (H3), and overall interaction experience (H4)—compared to the other three conditions. Other differences among the non-*MirrorBot* conditions were not central to our hypotheses, and we used them primarily to disentangle the contributions of robot presence and mirror-mediated gaze from their combination in *MirrorBot*.

4.3 Procedure

Two participants were scheduled to arrive simultaneously at the lab. Each session was facilitated by a lead researcher and two research assistants and lasted approximately 40 minutes. Participants were compensated with either $12 or 1.5 research credits.

4.3.1 Stage 1. Arrival and cover story. To observe natural interactions between strangers without priming, participants were recruited for a "Memory Challenge" study. Each research assistant greeted one participant individually, led them into the lab, and seated them in opposite corners of the lab space to minimize contact prior to the study.

After obtaining informed consent, participants completed a pre-survey in Qualtrics that included their demographic information and self-reported personality traits. They were then shown a series of short, neutral video clips[1] and answered a multiple-choice question after each clip to assess their short-term memory.

After both participants completed the test, the research assistants informed them that there would be a brief 10-minute waiting period while the team prepared the next phase of the study. Each assistant led one participant to an adjacent waiting room approximately 12ft by 12ft in size. The waiting room had a row of three chairs along one wall. Two cameras were installed in the left and right corners of the room for video recording and were covered with cloth to minimize their salience to participants.

4.3.2 Stage 2. Experimental manipulation. Upon entering the waiting room, participants were instructed to find a seat and were told they were free to talk, stand, walk, or relax during the waiting period, however they felt comfortable. The two researchers then left the waiting room, and the lead researcher started the video recording.

In the *MirrorBot* and *Bot-only* conditions, once the participants were alone, the lead researcher remotely controlled the robot from another room, which entered the room from behind a screen and navigated to a position equidistant to the two participants.

In the *MirrorBot* condition, the mirrors then sequentially activated three interaction modes: (1) Dual Self: showing each participant their own reflection for 30 seconds, (2) Dual Other: rotating mirrors to reflect the other person, and (3) Self + Other: splitting the mirror reflection between the self and the other, each for approximately one minute. Following this sequence, the *MirrorBot* behavior adapted in real time to the participants' level of engagement, controlled by the lead researcher. For instance, if participants remained disengaged or silent, the robot would lower its mirrors to signal "sadness." After approximately five minutes of interaction, the robot exited the room.

In the *Mirror-only* and *Control* conditions, the robot did not enter the room.

4.3.3 Stage 3. Final survey and debrief. After the 10-minute waiting period, the two research assistants re-entered the room, informed the participants that the session was over, and guided them back to the lab space. There, each participant completed a post-session survey assessing their experience of the waiting room, followed by a 10-minute individual semi-structured interview, which was audio-recorded with their consent. The survey questions and interview questions can be found in Appendix A and Appendix B, respectively. The two interviews were conducted in separate rooms to prevent cross-influence. Upon completion, participants were debriefed on the true purpose of the study, were asked if they had met each other before the experiment, and signed a debrief form in which they either consented to using their data or asked to withdraw it.

4.4 Participants

A total of 45 pairs (90 individuals) were recruited for the study through campus flyers and the university's recruitment system (SONA). Participant pairs were randomly assigned to one of the four experimental conditions upon arrival at the lab. Five pairs were later excluded from analysis due to either technical issues (e.g., robot connection failure) or because the participants were already acquainted with one another. Of the remaining 40 pairs (80 individuals), 12 were in the *MirrorBot* condition, 9 were in the Bot-only condition, 9 were in the Mirror-only condition, and 10 were in the Control condition.

Participants ranged in age from 18 to 50 years (M = 21.83, SD = 4.98); two participants did not report their age. 49 participants identified as female, 30 as male, and 1 as non-binary. 29 participants identified as White, 24 as East Asian, 8 as Black, 6 as South Asian, 6 as Bi-racial, 5 as Hispanic, 1 as Middle Eastern, and 1 did not report.

In the pre-survey, we examined participants' personality traits on 7-point scales (using the Ten Item Personality Measure (TIPI) [32]): extroversion, openness to new experiences, and reservation/quietness. No statistically significant differences in personality traits were found across the four conditions. The descriptive statistics of personality traits in each condition are reported in Appendix C.

4.5 Data Analysis

To evaluate how *MirrorBot* impacted social interactions compared to the other conditions, we collected (1) self-reported post-session survey data, (2) behavioral data from video-recordings, and (3) post-session individual interview recordings.

Post-session survey measures were selected or adapted from validated instruments in psychology and HCI research to ensure both construct validity and comparability with prior research. Since participants completed the study in pairs, the statistical analysis of survey responses needed to account for the potential non-independence of responses within dyads. Consistent with our hypotheses, we specified a priori planned contrasts comparing the *MirrorBot* condition to each of the three baseline conditions (Bot-only, Mirror-only, Control) within a mixed-effects model. Because the four conditions were coded with *MirrorBot* as the reference level, the fixed-effect coefficients directly estimate these *MirrorBot*–baseline differences, and we did not compute additional all-pairs post-hoc comparisons. These three contrasts correspond to our primary, theory-driven hypotheses, so we report their unadjusted p-values. The model structure was specified as: Measure ~ Condition + (1 | Group).

Behavioral measures were extracted from video recordings of participants in the waiting room. Three trained research assistants independently coded 10% of videos using a predefined coding scheme, the Strangers Interaction Framework [38], which characterizes behavior components during strangers' initial dynamics (Appendix F). Inter-rater reliability was calculated using a 30-second interval comparison method, yielding an agreement rate of 92%. Given this level of consistency, the remaining videos were divided between the three coders for independent annotation. Because total session time for each group varied slightly, we normalized the duration of each behavior by calculating the percentage of session time spent in that behavior at the group level. We then performed two-tailed t-tests to compare conditions and assess statistical significance.

[1]We used videos with neutral emotional content from the validated video library developed by Samson et al. [88].

Post-session interview recordings were transcribed using turboscribe.ai, then manually reviewed for accuracy. We conducted reflexive thematic analysis [14] to situate and interpret the quantitative results. Our analysis was primarily deductive, guided by the four outcome dimensions (initiating a conversation, interpersonal closeness, togetherness, and overall interaction experience), but we also allowed inductive codes to capture unanticipated ways participants made sense of the interventions. Three authors first independently open-coded approximately 25% of the transcripts, focusing on how participants described initiating interaction, feeling close or "together," and experiencing the robot and mirrors in the space. Through discussion, we consolidated these initial codes into a shared codebook, refining code names and definitions and agreeing on how to mark condition-specific versus cross-condition patterns. We then applied this codebook to the full set of interviews in a shared spreadsheet, iteratively updating codes and revisiting earlier transcripts when new interpretive insights arose. Throughout, the three authors met regularly to compare interpretations. The resulting themes were then organized around the four hypotheses (H1–H4) and used in the Findings section to explain and enrich trends observed in both the survey responses and behavioral measures, offering participants' subjective interpretations of the interaction experience.

Next, we present the metrics used to test each of the hypotheses, both from the surveys and based on analyzing behaviors in the video-recordings.

4.6 Metrics

Our hypotheses focus on four main outcome constructs: initiating a conversation (H1), interpersonal closeness (H2), togetherness (H3), and overall interaction experience (H4). For each construct, we selected validated survey scales and, where appropriate, behavioral measures that align with these dimensions. Survey measures and Behavior measures can be found in Appendix A and Appendix F. Below, we describe how each measure maps onto these constructs and supports our hypotheses.

4.6.1 H1. Initiating a Conversation.

Survey Measures. To assess the perception of initiating a conversation, participants first indicated whether or not they spoke to the other person during the waiting period (Yes/No). To further assess perceived ease and discomfort, we adapted items from Kardas et al. [50] to assess their retrospective experience of starting the conversation (Appendix A.6). Participants rated on a 10-point scale how easy, awkward, uncomfortable, and vulnerable they felt to initiate the conversation (e.g., "I would feel awkward to start the conversation").

Behavior Measures. To examine whether participants initiated a conversation, we marked the time participants first spoke to each other during the waiting period. For the *MirrorBot* and Bot-only conditions, we recorded the robot's entry time as "time zero", then measured the delay until participants began talking. For the Mirror-only and Control conditions, we subtracted the average robot entry time from *MirrorBot* and Bot-only conditions to create a comparable "time zero" baseline. This allowed us to assess whether and how the robot expedited conversational initiation. We also calculated the overall time in which participants talked to one another during the waiting period.

4.6.2 H2. Interpersonal Closeness.

Survey Measures. To assess interpersonal closeness, we focused on how close, warm, and overlapping the other person felt as a relationship partner after the interaction. Prior work in social and relational communication suggests that feeling close to another person is reflected in a constellation of perceptions—experiencing the other as warm and receptive, liking them and wanting to interact again, and perceiving overlap between self and other [10, 66, 69, 93]. Accordingly, we used three complementary validated measures, each targeting one facet of the interpersonal closeness:

(1) The Relational Communication Scale (RCS) [18] captures affective warmth and receptivity through 7-point items (e.g., "The other participant seemed warm and friendly").
(2) The Human-Human Liking Scale measures mutual liking and interest in future interaction [67, 84] (e.g., "I feel that my conversation partner is a very likable person", "I would very much enjoy talking to my conversation partner again").
(3) The Inclusion of Other in the Self Scale (IOS) [4] was used to measure perceived self–other overlap via an interactive web interface developed by Zhang et al. [102]: participants were asked to rearrange 75-pixel radius circles representing themselves, the other participant, and the robot (the latter only in the *MirrorBot* and Bot-only conditions). The initial circle layout was diagonal, and participants were instructed to "drag the circles into the arrangement that best represents your relationship with the other participant (and the robot, if relevant). The overlap between circles reflects "how close and connected you feel to each." We calculated the pixel distance between the centers of the Self and Other circles, following prior work on spatial representations of social distance [44, 77].

Behavior Measures. For behavioral measures of interpersonal closeness, we annotated the video recordings using categories adapted from Guo et al.'s framework on stranger interactions [38]. Coders attended primarily to what participants said, but also drew on visible body language and facial expressions (for example, shared laughter or visible embarrassment) when interpreting the interaction. Based on prior work that treats self-disclosure, partner-directed curiosity, and explicit emotional expression as key behavioral manifestations of emerging interpersonal closeness in early-stage encounters [4, 18], they coded two types of behaviors: (1) Self-disclosure, where a participant revealed personal information, experiences, or preferences about themselves (e.g., background, habits, or feelings). (2) Emotional revealing, where a participant explicitly expressed how they felt about the situation, the other person, or the robot/mirrors (for example, calling the interaction "awkward," "fun," or "surprisingly comfortable").

4.6.3 H3. Togetherness.

Survey Measures. To evaluate togetherness, we focused on participants' sense of shared presence and joint attention during the waiting period. Drawing on work on co-presence and social presence, we define "togetherness" as the subjective feeling of being

with another person in a shared situation: being mutually aware, attending to the same things, and feeling that messages and emotions are understood [8, 12, 40, 45]. In contrast to interpersonal closeness that captures how close the relationship feels overall, togetherness captures a situational feeling of "we are here together in this moment."

To operationalize participants' sense of togetherness, we used subscales from the Social Presence Scale [12, 13, 40] that examine the situational "being with" experience with another person. These four 7-point subscales are:

(1) Co-presence captures whether the other person felt psychologically present rather than merely co-located (e.g., "I was often aware of the other participant's presence") .
(2) Attentional Allocation reflects joint attention to a common focus, a core contributor to the feeling of "in something together" (e.g., "We were both attending to the same thing").
(3) Perceived Message Understanding indicates the sense that one's intentions are understood (e.g., "My thoughts were clear to the other participant").
(4) Perceived Affective Understanding captures attunement to the partner's emotional state (e.g., "I could tell how the other participant felt").

Behavior Measures. We coded behavioral indicators of togetherness from the video data, following Guo et al.'s framework on stranger interactions [38]. Coders attended to both what participants said and how they behaved nonverbally (e.g., gaze direction, body orientation, and object manipulation), coding three types of behaviors: (1) Shared attention, capturing episodes where both participants oriented toward the same target (e.g., robot, mirrors, phone, or room feature) at the same time, as evidenced by aligned gaze and posture, often accompanied by talk about that target. Note that the granularity of the behavioral data analysis did not allow us to distinguish between when the robot was stationary, moving, or when the mirrors were moving. (2) Mutual goals, capturing stretches of interaction where participants pursued a joint line of action, such as jointly inspecting the robot, co-constructing an explanation for its behavior, or coordinating how to respond to it. (3) Phone use, capturing periods when one or both participants withdrew attention from the shared setting to focus on their personal device, which was identified as a behavioral marker of disengagement from emergent co-presence [46].

4.6.4 H4. Overall Interaction Experience.

Survey Measures. To evaluate the overall interaction experience, we used scales that measure how satisfying a session feels in the moment [72]. Unlike interpersonal closeness and togetherness, which focus on the relationship between partners, interaction experience captures how participants evaluated the interaction itself. We used two scales:

(1) The Connection During Conversations Scale (CDCS) [72] was developed to capture how connected a specific conversation feels as an experience, with four 7-point item subscales:
   (a) Shared Reality reflects the sense that the conversation itself worked well, that both people were on the same page and jointly making sense of the interaction (e.g., "I felt in sync with the other participant").
   (b) Partner Responsiveness captures feeling noticed and cared for, a key dimension of whether an interaction is experienced as meaningful and supportive (e.g., "I felt the other participant cared about me").
   (c) Participant Interest indicates one's own engagement and curiosity, indicating whether the interaction felt intrinsically engaging (e.g., "I was interested in the other participant's thoughts and feelings").
   (d) Affective Experience captures the emotional tone of the episode (e.g., "I felt that my energy was drained by the interaction," reverse-coded).
(2) We also included 10-point affective ratings adapted from Kardas et al. [50] to capture participants' broader impressions of the conversation (e.g., "How happy do you feel about your conversation?", "How awkward was the conversation?", reverse-coded).

Behavior Measures. We did not include behavioral measures for this construct, relying instead on self-reports of perceived interaction experience.

4.6.5 Robot's Social Attributes.

Additionally, to complement the hypotheses testing, we included the Robotic Social Attributes Scale (RoSAS) [20], a validated instrument widely used in studies evaluating how robots are socially perceived in human-robot interaction scenarios involving expressive movement, social presence, and affective engagement [28, 51, 62]. RoSAS includes items that capture perceptions of the robot's sociability and emotional expressiveness, (e.g., "The robot seems interested in interacting with people") and the extent to which the robot's presence elicited unease (e.g., "The robot made me feel awkward"). Because only the *MirrorBot* and Bot-only conditions included a robot, the RoSAS items were administered only in these two conditions in order to explain potential differences discovered between them.

5 Findings

We begin the presentation of the findings by assessing the initial reaction that participants had to the intervention during the waiting period. We then present the main results for each of the hypotheses: initiating a conversation, interpersonal closeness, togetherness, and overall interaction experiences. We focus on the key statistically significant contrasts; full descriptive and inferential statistics, including all non-significant results, are in Appendix D. We then present exploratory analyses of participants' perceptions of the robot's social attributes (RoSAS). We further explored correlations between the personality traits and the outcome measures, and reported the results in Appendix G.

5.1 Initial Perception of the interventions

Because participants were initially told that the study was about memory and then unexpectedly encountered the interventions in the waiting room, we examined their first reactions using video and interview data. In most *MirrorBot* and *Bot-only* sessions, participants paused what they were doing when the robot entered, turned their heads or bodies to follow it, and often smiled, laughed,

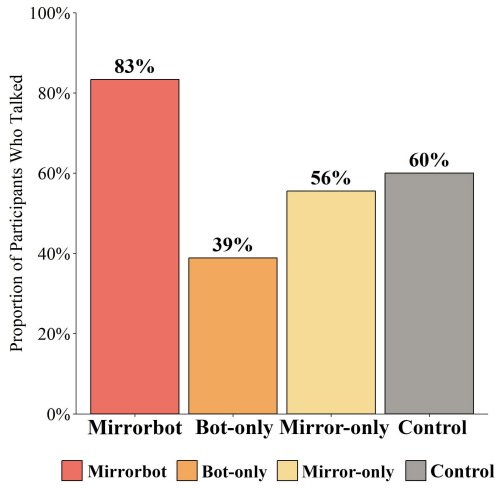


Figure 7: Proportion of Participants Who Reported Initiating a Conversation by Condition

or exchanged brief remarks or glances with their partner. In interviews, many first said they "didn't know" what the robot was doing, then described its purpose as "trying to get our attention," "a conversation starter," or "another presence in the room." Several presumed that it was intentionally related to the memory task, for example, "distract us from the memory challenge" or "get us to forget the video we watched earlier." In the static Mirror-only condition, participants typically said they noticed the mirrors but "didn't pay much attention," using them occasionally to check their appearance or briefly seeing the other person's face; a few described these mirror-mediated glances as "a bit awkward," but most treated the mirrors as ordinary fixtures rather than a strong intervention.

5.2 Initiating a Conversation

Our first hypothesis (H1) predicted that participants in the *MirrorBot* condition would find it easier to start a conversation than in the other conditions. As shown in Figure 7, a higher percentage of participants in the *MirrorBot* condition reported initiating a conversation (83%), followed by the Control condition (60%), the Mirror-only condition (56%), and the Bot-only condition (39%).

Further, participants in the *MirrorBot* condition reported the most positive experiences in initiating a conversation, indicating feeling the least awkward, uncomfortable, and vulnerable feelings, and the highest ease when initiating a conversation, as shown in Figure 8. On the "awkward" item, we observed a significant increase in the *Control* condition ($M = 4.45$, $SD = 1.73$, $\beta = 1.16$, $SE = 0.55$, $p = 0.038$) compared with the *MirrorBot* condition ($M = 3.29$, $SD = 1.76$). Similarly, the "uncomfortable" score was significantly higher in the *Control* condition ($M = 4.30$, $SD = 1.69$, $\beta = 1.47$, $SE = 0.50$, $p = 0.005$) than in the *MirrorBot* condition ($M = 2.83$, $SD = 1.37$). The "vulnerable" score in the *Control* condition didn't significantly differ from that in the *MirrorBot* condition ($p = 0.060$).

The *Bot-only* condition appeared to be the second lowest regarding the experience of initiating a conversation. Its scores didn't significantly differ from that in the *MirrorBot* condition on the "awkward" item ($p = 0.086$) and the "uncomfortable" item ($p = 0.090$). Moreover, the score of "ease" was significantly lower in the *Bot-only* condition ($M = 3.78$, $SD = 1.70$, $\beta = -1.14$, $SE = 0.49$, $p = 0.025$) than in the *MirrorBot* condition ($M = 4.91$, $SD = 1.14$). The full descriptive and inferential statistics are in Appendix D, Table 7.

From the video recordings, we measured the percentage of the average amount of time each group spent talking with one another in each condition: *MirrorBot* 46.3 % ($SD = 38.4\%$), Bot-only 21.1 % ($SD = 38.8\%$), Mirror-only 30.7 % ($SD = 42.3\%$) and Control 45.8 % ($SD = 47.8\%$). No significant differences were found between the conditions in the percentage of time participants talked during the session. Full descriptive and inferential statistics are reported in Appendix E, Table 9.

Qualitative analysis of the post-session interviews further illuminates how *MirrorBot* lowered the perceived barrier to starting a conversation, complementing the quantitative pattern of higher perception of initiation rates and reduced awkwardness. Many participants described the robot as giving them "something to do" or "something in common to talk about," making the situation "less awkward" and diffusing the intensity of silence (e.g., P126, P410). Rather than needing to "make the first move" out of nowhere, participants often began talking by commenting on the robot, using it as a neutral, shared anchor for attention and an indirect path into conversation.

A second theme was the role of ambiguity and co-attention. Several participants said the robot's unexpected appearance and unusual behavior made them look to each other for validation or interpretation (e.g., P108: *"we were both just looking at each other… what the heck is going on?"*). Co-attending to "something strange" created a shared emotional state and a natural reason to engage, with some reporting that *"Just the fact that we were both focused on the same thing and probably had similar feelings about it,"* said P108, *"made me feel more connected to her."*

Finally, participants highlighted the mirrors as enabling indirect visual contact. As P120 put it, *"when we are both looking at the robot… we're seeing each other,"* describing a kind of ambient eye contact that felt less confrontational than direct staring but still allowed monitoring each other's reactions. In contrast, participants in the Control and Mirror-only conditions described relying on internal motivation or social obligation ("filling the silence," P410) or avoiding conversation out of uncertainty. Additionally, *Bot-only* participants often felt that the robot lacked the visual anchoring, so it was difficult to assess each other's interest. As one participant put it, "*it did help… but just didn't help enough for me to start a conversation" (P202).* These themes help explain why *MirrorBot* participants perceived to initiate conversations more often and reported less awkwardness and discomfort when doing so.

Overall, while behavioral data do not suggest that participants in the *MirrorBot* condition initiated conversation more than in the other conditions, self-reported survey data suggest that they *perceived* to do so, and experienced the greatest ease and the lowest levels of awkwardness, discomfort, and vulnerability when starting a conversation. We therefore conclude that H1 is partially supported.

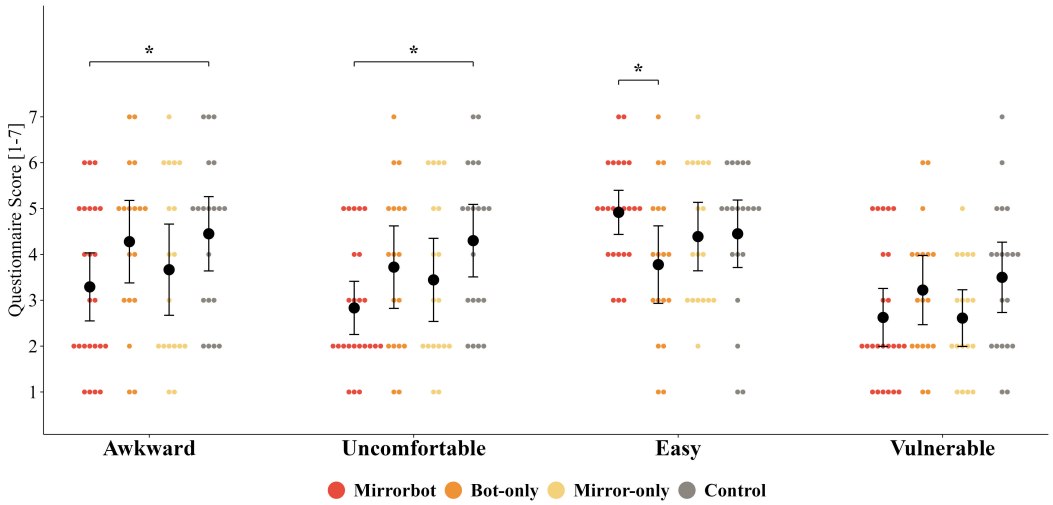


Figure 8: Survey Findings of Experiences when Initiating a Conversation on 4 items: feeling awkward, uncomfortable, easy, and vulnerable. Colored dots show individual participants' scores in each condition (*MirrorBot*, Bot-only, Mirror-only, Control). Black circles indicate means, vertical lines indicate 95% confidence interval error bars. Brackets with asterisks mark pairwise differences significant at $p < .05$.

5.3 Interpersonal Closeness

H2 predicted that participants in the *MirrorBot* condition would feel closer to the other participant. Using the Relational Communication Scale and the Human–Human Liking Scale to evaluate interpersonal closeness, no significant differences were observed between the conditions on either scale. Full descriptive and inferential statistics of the two measures are reported in Appendix D, Table 4 and Table 3.

To further examine perceived closeness, the analysis of the visual Inclusion of Other in the Self Scale (IOS) revealed significant differences between the conditions, as shown in Figure 9 and Figure 10. In the *MirrorBot* condition, the Self and Other circles overlap the most ($M = 124.85$, $SD = 76.54$), indicating the strongest sense of interpersonal closeness. The *MirrorBot* condition showed the lowest perceived distance between self and other, but this difference was statistically significant only in relation to the Mirror-only condition ($\beta = 151.71$, $SE = 40.61$, $p = 0.0006$) (Fig. 10).

Moreover, both the Self–*MirrorBot* ($M = 143.78$) and Other–*MirrorBot* ($M = 150.22$) distances are shorter than those in the Bot-only condition ($M = 166.57$, and $M = 175.28$, respectively), as shown in Figure 9. This suggests that participants perceived *MirrorBot* not just as a tool but as part of the shared social space that is more embedded in the triadic relationship. In contrast, in the Bot-only condition, the robot was placed more distant and external to the interpersonal dyad, implying a weaker integration of the facilitator into the shared interaction space. Full descriptive and inferential statistics are reported in Appendix D, Table 5.

In terms of the behavioral measures from video recordings, groups in the *MirrorBot* condition demonstrated significantly higher levels of "Emotional Revealing" behaviors ($M = 8.8\%$, $SE = 6.1\%$, $p = 0.016$) compared to the Mirror-only condition ($M = 2.7\%$, $SE = 4.1\%$). Besides that, no significant differences were found between the conditions in the behavioral measures of "self-disclosure" or "information-seeking." Full descriptive and inferential statistics are reported in Appendix E, Table 9.

Interview data help offer additional context for how participants experienced interpersonal closeness in the *MirrorBot* condition. Participants described feeling "a bit closer" to their partner from shared reactions to a novel, ambiguous situation and the subtle coordination that followed. They described "checking in" with each other before approaching the robot, smiling at each other in the mirrors, or realizing they were equally confused. For example, P124 recalled that *"both of us were hesitant until both of us went up to look at it together… like checking with the other person if it was okay,"* framing closeness as "safety in numbers" and quiet mutual validation.

A second theme was shared emotional resonance. Participants reported that seeing the other person's reactions shaped their own—through shared laughter, surprise, or mild awkwardness. P117 noted, *"I saw the other participant in the mirror… I just smiled a little bit, which I think added more positivity… You see another person, you just go, hello."* In some cases, even discomfort with the robot became a joint experience: P108 initially felt uneasy being watched, but felt reassured once she realized the robot was also looking at her partner—*"if it was only looking at me, I'd probably be more uncomfortable… but since it was happening to another person… this is probably fine."* These suggest that *MirrorBot* sometimes synchronized affect between strangers, regardless of whether the emotion was purely positive. However, it's worth noting that participants framed these moments of closeness as fleeting. Some described the connection as tied to the robot's novelty—such as jointly watching or recording the robot—and noted that "the novelty wore off

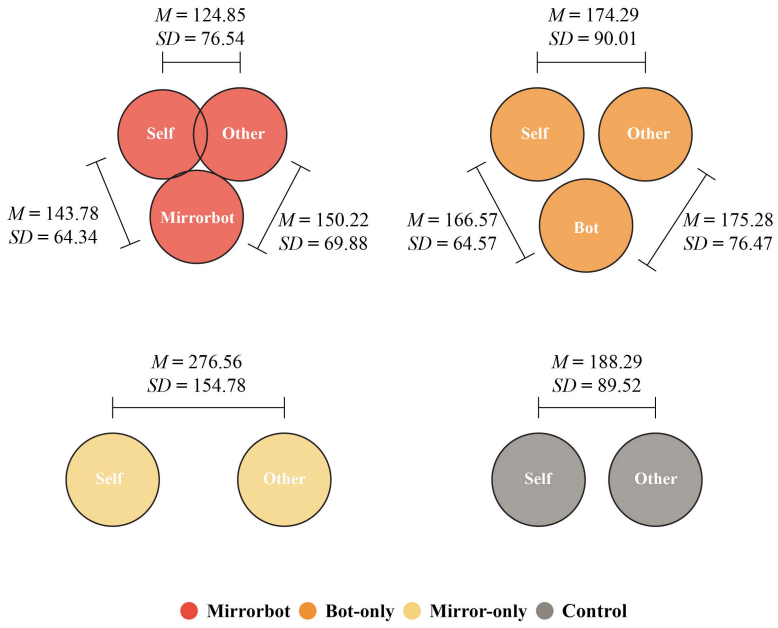


Figure 9: The distances between the centers of the circles represent the average perceived distance (in pixels) between the participant (Self), their conversation partner (Other), and the robot (*MirrorBot* or Bot-only conditions).

later" (P123). This helps contextualize the mixed quantitative results: *MirrorBot* did not uniformly raise all closeness scores, but it did create short, shared emotional episodes that some participants experienced as increased interpersonal closeness.

To summarize, our findings provide partial support for H2: on some of the metrics, we found that participants in the *MirrorBot* condition exhibited the lowest perceived distance and highest interpersonal closeness, but only in relation to the Mirror-only condition.

5.4 Togetherness

To test H3—that participants in the *MirrorBot* condition would experience a higher sense of togetherness, defined as mutual awareness and social presence—we analyzed responses across four subscales from the Social Presence Scale: Co-presence, Attentional Allocation, Perceived Message Understanding, and Perceived Affective Understanding.

As shown in Figure 11, participants in the *MirrorBot* condition reported the highest scores on some of the subscales of the Social Presence Scale, but these differences were not statistically significant. Full descriptive and inferential statistics are reported in Appendix D, Table 8.

In terms of the behavioral measures from video recordings, groups in the *MirrorBot* condition demonstrated significantly higher levels of "shared attention" behaviors (M = 23.0%, SE = 11.1%,) compared to Bot-only (M = 10.4%, SE = 9.8% p = 0.013), Mirror-only (M = 2.1%, SE = 3.8% $p < 0.001$), and Control condition (M = 2.2%, SE = 6.4% $p < 0.001$). Besides that, no significant differences were found between the conditions in the behavioral measures of "mutual goals" or "mobile phone use." Full descriptive and inferential statistics are reported in Appendix E, Table 9.

The qualitative interview responses shed some light on how *MirrorBot* facilitated unique experiences of togetherness as mutual awareness and shared presence. Several participants described noticing each other and the room once the robot entered, saying that *"everything was magnified because the robot was here... being able to see each other more directly, not just out of the peripheral (P114)"*. Some described that the robot created a shared field of attention that made it easier to be mutually aware—both people were tracking the same moving object—without feeling obliged to talk. These are consistent with togetherness as an ambient sense of "being in something together," even when the interaction was brief or light.

Mirrors also played a role in how participants calibrated this mutual awareness. Some used them to monitor both self and other without the pressure of direct eye contact. P119, for example, noted that *"seeing myself in the mirror... I can make sure that my face doesn't look weird"* and that *"you're gauging the reaction... but it's less of a direct stare that feels intimidating,"* suggesting a low-stakes way to stay attuned to the partner's presence and affect. In the static Mirror-only condition, however, mirror-mediated awareness sometimes felt unsettling rather than affiliative; a few participants described *"awkward... suddenly making eye contact through the mirror"* (P301) and reported avoiding looking at it, suggesting that static mirrors lacked a clear social signal for framing the interaction.

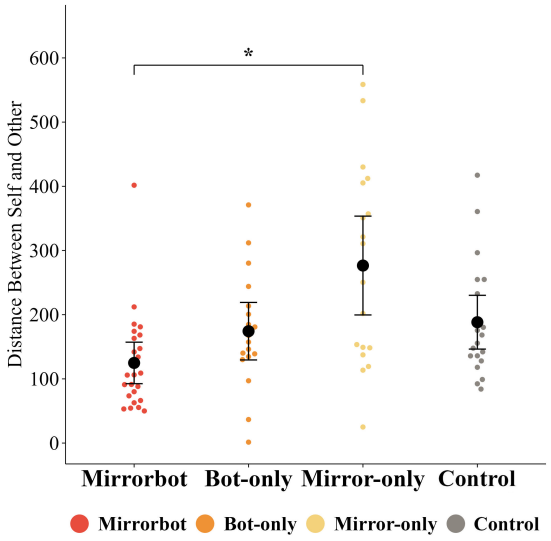


Figure 10: Average perceived distance between participants and their conversation partner across four conditions: *MirrorBot, Bot-only*, Mirror-only, and Control. Each dot represents a participant's reported distance (in pixels) based on the circles' rearrangement, and the black dot denotes the group mean with standard error. (*) denotes $p < 0.05$.

In summary, these suggest that the interventions sometimes supported an ambient sense of social presence—being mutually aware and co-attending to what was happening in the room—but that this effect was fragile and not uniformly positive across participants or conditions, which helps explain the lack of strong quantitative differences on the social presence scales.

Overall, these findings provide partial support for H3: *Mirrorbot* induced a higher sense of togetherness from behavior metrics of "shared attention", compared to Bot-only, Mirror-only, and Control.

5.5 Overall Interaction Experience

To test H4, pertaining to the overall interaction experience, we examined how participants respond to the Connection During Conversation Scale (Figure 12), and a questionnaire about their conversation experience: happy, awkward, uncomfortable, enjoyable, and vulnerable (Figure 13).

The Connection During Conversation Scale did not demonstrate statistically significant differences in the "shared reality", "participant interest" and "partner responsiveness" subscales. The only statistically significant difference was found in the "affective experience" subscale, where participants in the *MirrorBot* condition reported a significantly higher score ($M = 5.58$, $SD = 1.12$), than in the Bot-only condition ($M = 4.46$, $SD = 0.95$, $p = 0.005$). The full descriptive and inferential statistics are reported in Appendix D, Table 2.

For the conversation experience questionnaire, we found statistically significant differences in the positive emotion scores "Happy" and "Enjoyable" between the *MirrorBot* and the Mirror-only conditions. The "Happy" score in the *MirrorBot* condition ($M = 5.88$, $SD = 3.04$) was significantly higher than in the Mirror-only condition ($M = 3.22$, $SD = 2.96$, $p = 0.03$). The "Enjoyable" score in the *MirrorBot* condition ($M = 5.42$, $SD = 3.05$) was significantly higher than in the Mirror-only condition ($M = 2.56$, $SD = 2.92$, $p = 0.025$). We did not observe any significant differences on the "Awkward", "Uncomfortable", and "Vulnerable" items. The full descriptive and inferential statistics are reported in Appendix D, Table 6.

Interview data help contextualize the mixed H4 support on interaction experience. In the *MirrorBot* condition, many participants described the waiting-room episode as "playful," "funny," or "less awkward than just sitting in silence," and said the robot gave them "something to talk about" or "an excuse to look up" and exchange comments. For example, P108 remarked that the co-experience of the robot's strangeness *"made me feel more connected to her,"* while P120 noted that the moving mirrors drew their attention in a way that felt engaging rather than confrontational. These accounts are consistent with the higher affective experience and happiness/enjoyment scores observed for *MirrorBot* in some of our measures.

At the same time, not all participants experienced the intervention positively. Within the *MirrorBot* condition, a few participants found the robot "annoying" or "a bit unsettling" when its movements were unexpected. In the Mirror-only condition, some described mirror-mediated eye contact as "awkward", and in Bot-only, several reported that the robot was "interesting but kind of just there," lacking a clear role in the interaction. Taken together, these qualitative accounts suggest that the interventions sometimes improved the emotional tone and memorability of the interaction, but this effect was uneven across participants and conditions, aligning with the partial quantitative support for H4.

Overall, our findings provide partial support for H4: On some constructs of interaction experience, participants in the *MirrorBot* condition reported higher affective experience, felt happier, and a more enjoyable experience compared to some of the other conditions.

5.6 Robot's Social Attributes

As an exploratory analysis, we examined how participants evaluated the robot's social attributes using the Robotic Social Attributes Scale (RoSAS). We found no significant differences on most RoSAS items between the *MirrorBot* and the Bot-only condition. Interestingly, the robot without the mirror was perceived to express more emotions ($M = 4.46$, $SD = 1.29$, $\beta = 1.18$, $SE = 0.44$, $p = 0.009$) than *MirrorBot* condition ($M = 3.38$, $SD = 1.53$). The Bot-only condition was also rated as showing greater interest in interacting with people ($M = 5.28$, $SD = 1.07$, $\beta = 1.24$, $SE = 0.50$, $p = 0.021$) compared to the *MirrorBot* condition ($M = 4.04$, $SD = 1.81$) (See Figure 14).

6 Discussion

Across the four outcome dimensions—initiating conversation, interpersonal closeness, togetherness, and overall interaction quality—the conditions did not shift all aspects of social interaction in the same way. *MirrorBot* most reliably helped strangers perceive

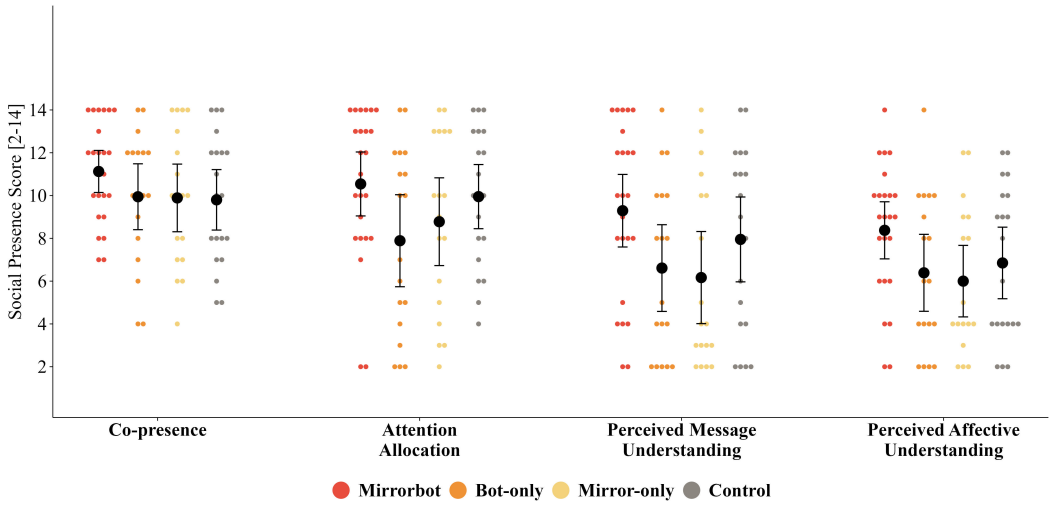


Figure 11: Survey Findings of Perceived Social Presence with four subscales: co-presence, attention allocation, perceived message understanding, and perceived affective understanding. Colored dots show individual participants' total scores in each condition (*MirrorBot*, Bot-only, Mirror-only, Control). Black circles indicate means, vertical lines indicate 95% confidence interval error bars. The y-axis shows aggregated score for the two items in each subscale (range = 2–14).

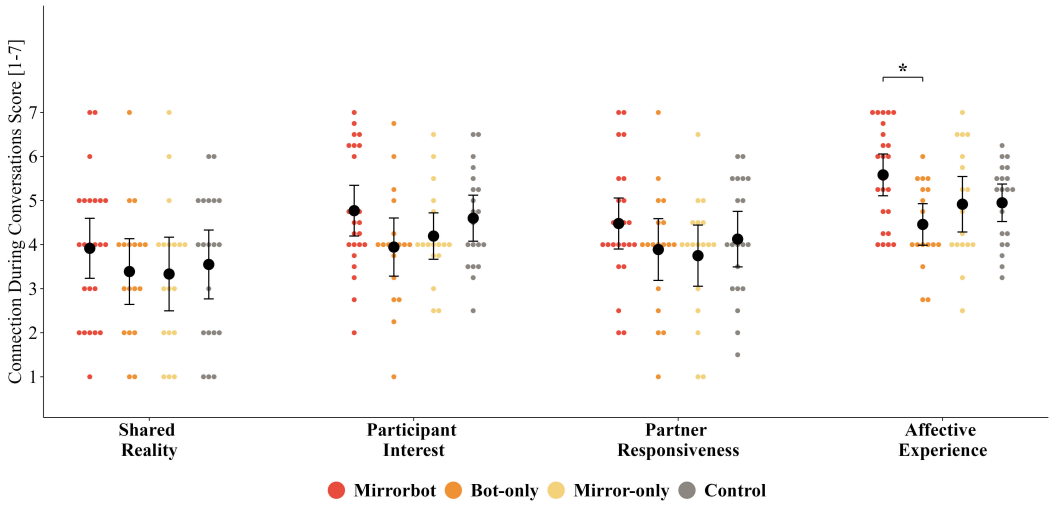


Figure 12: Survey Findings of Connection During Conversation Scale with four subscales: shared reality, participant interest, partner responsiveness, and affective experience. Colored dots show individual participants' average scores in each condition (*MirrorBot*, Bot-only, Mirror-only, Control). Black circles indicate means, vertical lines indicate 95% confidence interval error bars. Brackets with asterisks mark pairwise differences significant at $p < .05$.

that they could cross the first-move barrier and added the interaction with a more positive affective tone. At the same time, *MirrorBot* did not always enhance the interaction in the direction that our hypotheses predicted. Descriptively, Mirror-only was often worse than the Control, and Bot-only sometimes performed worse than Control as well, despite being rated as more socially expressive than *MirrorBot*. The results suggest that different elements of the intervention (robot, mirrors, movement) can either scaffold or disrupt fragile social norms in a waiting-room encounter.

Building on these results, in the following sections, we first discuss the design and deployment of *MirrorBot* in facilitating strangers' interaction and its broader implications. We then zoom out to consider mirrors as a social and playful material in their own

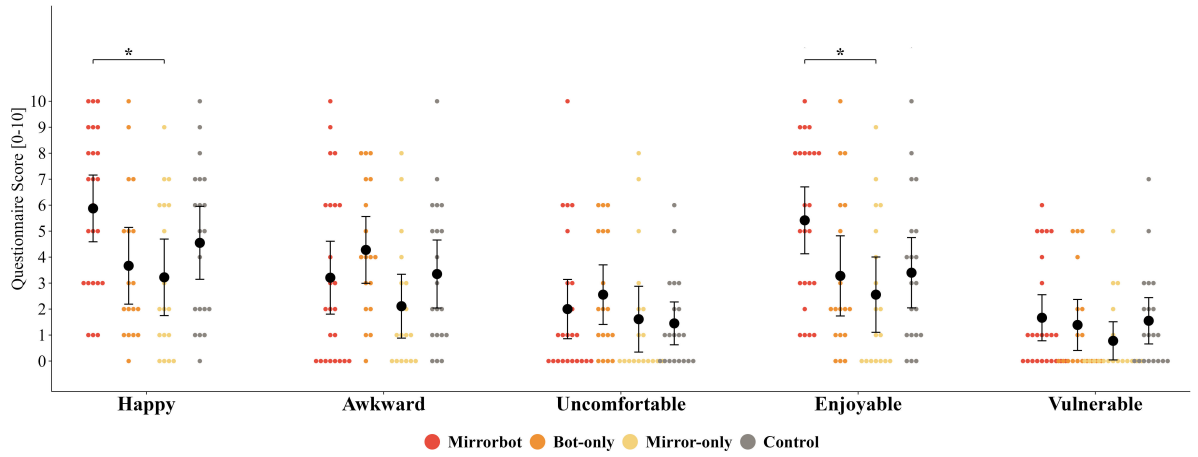


Figure 13: Survey Findings on Overall Interaction Experience with 5 items: feeling happy, awkward, uncomfortable, enjoyable, and vulnerable. Colored dots show individual participants' ratings in each condition (*MirrorBot*, Bot-only, Mirror-only, Control). Black circles indicate means, vertical lines indicate 95% confidence interval error bars. Brackets with asterisks mark pairwise differences significant at $p < .05$.

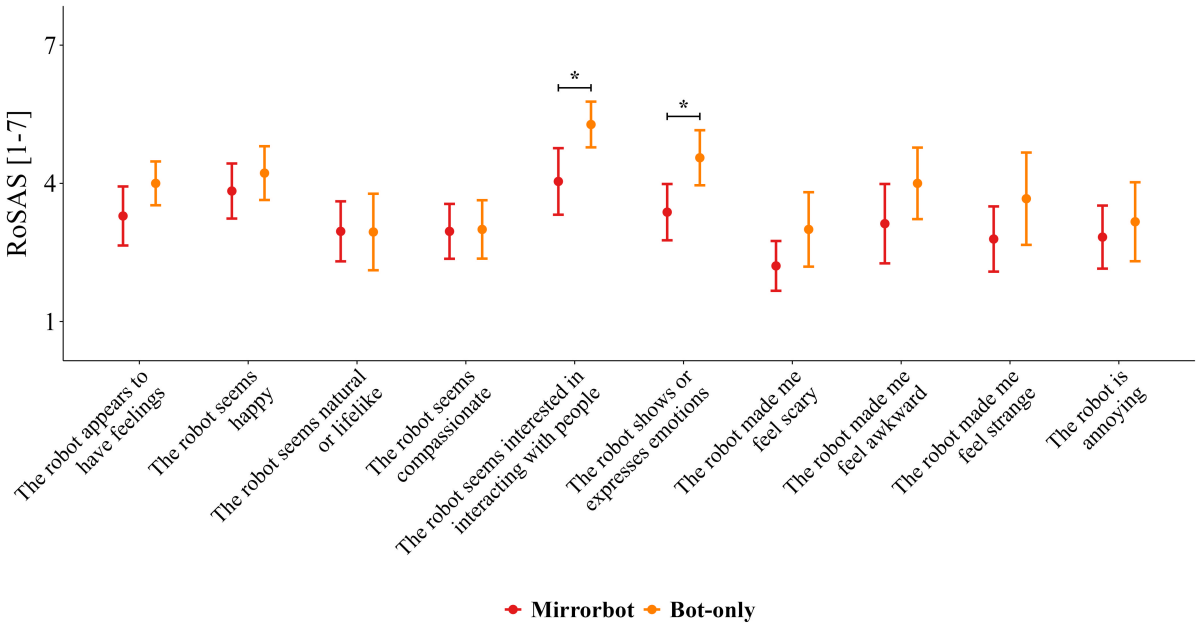


Figure 14: Survey Findings on Robotic Social Attributes Scale (RoSAS), only applied in the *MirrorBot* and Bot-only conditions. Colored intervals show mean and 95% confidence intervals for each condition. Brackets with asterisks mark pairwise differences significant at $p < .05$.

right, drawing connections to prior work on ludic and public interaction. Finally, we translate these insights into design implications for ice-breaking technologies.

6.1 *MirrorBot* as a Facilitator of Stranger Interaction

In this subsection, we discuss the design, deployment, and implication of *MirrorBot*: we first unpack how the specific design elements

of mirror, robot, and movement worked together, then examine how the teleoperated behavior in our study points toward challenges for autonomous implementations, and consider what these patterns imply for how we conceptualize the role of social robots in supporting human-human encounters. Finally, we discuss the broader implications of *MirrorBot* as a socio-spatial interface that works by configuring sight lines of visibility in space, pointing toward future designs that move along a spectrum from discrete robots to more distributed spatial interventions.

6.1.1 *Effects of the Design Elements: Mirror, Robot, and Movements.*

Our findings provide partial support for the hypotheses on the impact of *MirrorBot* on human interaction. Participants in the *MirrorBot* condition were most likely to report that they talked with the other participant, reported the lowest awkwardness and discomfort, and the greatest ease when initiating (H1). They perceived themselves to be closer to the other participant and engaged in more emotionally revealing talk than Mirror-only (H2), and reported more positive affective experience, happiness, and enjoyment than at least some other conditions (H4). At the same time, while participants in the *MirrorBot* condition tended to score higher on some scales that indicate togetherness (H3), this did not reach statistical significance. We now turn to interpret why this combination of robot and moving mirrors was helpful for some of the interactions between strangers in some ways.

First, *MirrorBot* gave people a legitimate pretext to break civil inattention: instead of "deciding" to talk to a stranger, they could comment on a visible, surprising event, which both participants clearly noticed. This fits classic accounts of public interaction where people need a safe, externally supplied reason to speak so they do not feel they are intruding on the other's autonomy [22, 31].

Second, the moving mirrors created a structured form of indirect gaze: when both people looked at the robot, they could also see each other in the mirror without committing to full eye contact. Participants described this as a way to "check in" on the other and on their own appearance that felt less confrontational than staring or orienting their bodies to one another, but still gave them cues about the other's interest or affect. This aligns with work on gaze regulation and gaze equilibrium, which emphasizes that people manage intimacy by adjusting how directly and how long they look at one another [3, 54].

Third, the combination of a shared puzzle ("what is this?") and subtle micro-coordination (hesitating together before approaching, laughing together at its movements, sharing mild discomfort) created short episodes of co-attunement. Theories of shared reality [94] and emotional contagion [41] suggest that such co-attended, co-evaluated events can produce a sense of "being on the same page" even in brief interactions. In our data, these episodes did not translate into uniformly higher scores on all closeness or social presence scales, but they do help explain why *MirrorBot* sits at the top descriptively on initiation and affective experience, and why some participants described feeling a bit closer or more connected even when the conversation remained brief.

What about static mirrors? The Mirror-only condition performed worse on several key dimensions compared to *MirrorBot*, and even worse than the Control condition on several measures. Descriptively, Mirror-only participants were less likely to report talking than in Control, talked for less time, reported the largest self–other distance on the IOS measure, and scored lowest on happiness and enjoyment. Interviews clarify why static mirrors can backfire. Without movement or framing, the mirrors rarely functioned as a shared object of curiosity; many participants simply said they noticed the mirror but did not pay much attention, occasionally using them to check their own appearance. When the other person in the mirror did enter awareness, it was a source of momentary awkwardness, rather than as an invited, shared activity.

This maps onto work on objective self-awareness and mirrors: being confronted with one's own image can heighten self-consciousness and evaluation anxiety, especially in social contexts, without providing any clear script for what to do next. In our setting, the static mirrors amplified visibility (you can see yourself and the other) without offering any timing, motion, or social cues for what to do next. As a result, they might have caused participants to be more cautious about looking up at all. It is therefore possible that adding mutual reflection without choreography can increase self-focus and ambiguity without supplying the conversational pretext or indirect gaze structure.

What about a moving robot without mirrors? The Bot-only condition showed a different kind of failure mode. Here, there is a robot but no mirror, and descriptively this condition often looks as weak—or sometimes weaker—than the Control condition on human–human outcomes. Participants in Bot-only were least likely to report that they talked at all, reported lower ease and sometimes higher awkwardness and discomfort around initiating than *MirrorBot*, and did not show advantages on closeness, togetherness, or affective experience. However, RoSAS ratings indicate that the Bot-only robot was perceived as more emotionally expressive and more interested in interacting with people than *MirrorBot*. Interviews suggest that the robot in this condition tended to become a competing social object rather than a facilitator. Without mirrors to redirect attention to the other person, its movements and non-reflecting "eyes" drew focus to the robot. Some participants interpreted it as trying to interact with them personally, or as a device recording their behavior, and several chose either to ignore it deliberately or to focus on inspecting the robot's construction instead of engaging their partner.

Prior HRI work has shown that robots positioned as central social actors can sometimes pull attention away from human–human interaction, especially when their role is unclear or when they lack fine-grained responsiveness to the unfolding conversation [43, 81]. It also shows that perceptions of robot socialness are tightly coupled to where attention is directed [58, 103]. Our findings extend this work by showing that a robot can be most socially useful when it is not the center of social meaning, but instead reshapes the interactional field so people can notice each other. Socially effective robots may be those that recede, orchestrating the social stage for people, rather than occupying its spotlight.

6.1.2 *Teleoperation and Autonomy.*

In this study, *MirrorBot*'s navigation and switches of mirrors' states were teleoperated. This limits its current autonomy, but it also clarifies what control decisions an autonomous version would need

to make in the wild. The qualitative data highlight several such decisions: when to approach or keep distance; when to reposition mirrors toward self, other, or both; when to remain still and fade into the background; and when to exit so as not to overstay the novelty.

Real-world deployments would require policies that infer, from sparse cues, whether people are open to engagement, already absorbed in their own activities, or actively avoiding attention. Social interaction is a wicked problem [85]: there is no single correct response, and the meaning of a robot's action depends on history, setting, and individual preference. Simple rule-based policies are therefore unlikely to generalize. Instead, an autonomous *MirrorBot* would need to adapt its behavior on site, drawing on cues such as posture, mutual orientation, conversational flow, and ongoing activity, in line with broader HRI work on modeling engagement and disengagement in public and semi-public spaces [71, 96].

Our findings suggest that for facilitators like *MirrorBot*, success may depend less on rich social expressiveness and more on timing and selectivity of actions. The robot is most helpful when it appears at moments when an additional shared focus is welcome, and withdraws once it begins to compete with or disrupt human-human interaction. Autonomy, in this sense, is not about sustaining continuous interaction, but about learning when to do nothing, when to stage a brief joint event, and when to leave.

6.1.3 *The Role of Social Robots.*

Social robots are typically defined as artefacts that use social cues such as gaze, body orientation, movement, and affective expression to engage humans [15, 23, 26]. In this sense, *MirrorBot* is a social robot: it senses where people stand, reorients its mirrors and body responsively, and exhibits motion patterns that participants interpreted as attentive or gently inviting. Participants described it as "noticing," "encouraging," or "checking in," treating its sensorimotor behavior as social signals even though *MirrorBot* does not speak.

However, our results point to a different design goal for social robots. Although being "more social" is often equated with being more agent-like, expressive, and communicative, we found this does not necessarily make people more connected to each other. In the Bot-only condition, the robot was rated as more emotionally expressive and more interested in interacting with people than *MirrorBot*, yet it did not improve human-human outcomes and sometimes performed even slightly worse, than the Control on talking at all, ease of initiating, and affective experience. We infer that for Bot-only, the robot became a competing social object rather than a facilitator: without mirrors to direct attention through the other person, its movements and gaze drew focus toward itself.

This positions *MirrorBot* within a growing class of robots that support social interaction indirectly, through peripheral action, subtle disruptions, and environmental modulation rather than overt performance. Prior work such as *Kip1* [43] in calm technology [101] demonstrates that gentle attentional cues can be more socially catalytic than rich expressive behaviors. We therefore argue that *MirrorBot*'s sociality lies less in performing social interaction with users, but more in making interpersonal perception easier by redistributing people's attention towards each other.

Participants accordingly interpreted *MirrorBot* in multiple, and sometimes conflicting roles: a quiet ambient participant or "listener," a mediator or conversation starter, a pet- or child-like presence seeking acknowledgment, a magnifier of social awareness, and at times an unnecessary "middleman" or even a disrupter. These varied readings underscore that the value of such systems does not lie in a fixed social role. Instead, robots in public settings benefit from supporting flexible roles, enabling people to treat them as facilitator, background presence, or something to ignore, depending on comfort and context.

6.1.4 *From Robots to Socio-Spatial Interfaces.*

The mechanisms we observe with *MirrorBot*—indirect gaze, shared attention to a moving reflective object, and short episodes of co-attuned surprise—are not unique to robots. In principle, they could be realized by non-robotic kinetic installations: for example, ceiling or wall mounted mirrors that tilt in response to people's locations, or interactive furniture and projections that briefly align sight lines between strangers. Prior work has already used interactive furniture [53], urban projections [42], large-scale installations [27], and public displays [76, 100] to create shared moments of attention in public space. Our findings add moving mirrors to this repertoire and point to a broader design space in which reflection and motion are treated as materials for staging joint attention between strangers.

At the same time, the fact that the mirrors are mounted on a robot with a clear chassis creates its unique meaning. Participants interpreted *MirrorBot* as "something that entered the room," a "presence," or a "small child wanting attention." The robot's ability to roll in, reposition itself, and then withdraw makes the timing of the intervention legible: it arrives, does something, and then leaves. A permanently installed kinetic mirror may be easier to background as ambient infrastructure. The robot form also leverages existing cultural expectations that "this object has a purpose," which several participants connected to the study's memory cover story ("it is trying to get us to forget the videos," "it is recording how we react").

We therefore read *MirrorBot* as an instance of a socio-spatial interface [36, 56]: a system that reshapes how people perceive and inhabit a shared environment rather than a stand-alone social agent. Socio-spatial interfaces work by modulating spatial relations, here lines of sight, reflective views, and the timing of visibility, to mediate social interaction. In our case, *MirrorBot* has a clear body boundary, yet its primary effect is to reconfigure the visual field between strangers. Future work can push this further by dissolving that boundary, exploring distributed or architectural implementations (for example, multiple small moving mirrors or responsive surfaces) and examining how people's behavior and meaning-making of the intervention change when the mediating system is experienced less as a single actor and more as part of the environment itself.

6.2 Mirrors as a Social and Playful Material

In this subsection, we zoom out to discuss mirrors as a design material: we first situate mirrors within ludic design as an underused medium for playful, co-present interaction. We then discuss how careful framing, consent, and alternative focal elements are needed so mirror-based interventions lower rather than raise social barriers.

6.2.1 *Mirrors for playful interaction.*

A long line of HCI work has argued for designing technologies that

invite open-ended, non-instrumental play rather than narrowly task-focused use. Ludic design, for example, explores artefacts like the *Drift Table* [29, 30] that encourage curiosity, daydreaming, and lingering engagement without a clear productivity goal. Similarly, work on playfulness [55] and the PLEX framework [64] articulates experiential qualities, such as exploration, humor, and fellowship, as design resources rather than side-effects. In public and semi-public settings, playful benches [53], stools [87], and installations [35] have been used to trigger serendipitous encounters, sometimes even leveraging discomfort or awkwardness in carefully controlled ways. Within this broader trajectory, our study suggests that mirrors are an underused but promising material for designing situated, co-located play.

Most playful public technologies rely on screens, projections, or conspicuously "interactive" objects. By contrast, *MirrorBot* builds on an object that is deeply mundane and already embedded in everyday architecture. Participants treated the mobile mirror as both ordinary (a piece of furniture they understood immediately) and strange (a moving, selective, and social reflection). Their behaviors, such as laughing at how the mirror "caught" both faces, using reflections to discreetly check in on each other, or treating the robot as a shared "third thing" to talk about, point to a design space where mirrors support light, in-the-moment play. Beyond our current prototype, mirrors could also be used to redirect attention toward overlooked parts of the environment, reflecting interesting views or activities to invite people to notice their surroundings more carefully. They could also support social mirroring as a cooperative puzzle, where certain reflections, icons, or patterns only appear when two or more people coordinate their positions, turning mirror-gazing into a small collaborative challenge. Or, as another example, temporal manipulations, such as delayed reflections or fading "ghost traces" of prior movements, could make the mirror a playful record of shared presence over time, echoing work on ambient data traces and ludic visualizations in public space [27].

6.2.2 *Playfulness with mirrors requires framing, consent, and alternatives.*

Mirrors are not neutral. For some participants, *MirrorBot* created a light, funny experience and "less awkward than just sitting in silence." For others, mirror-mediated eye contact felt sudden or exposing, and static mirrors in particular sometimes amplified self-consciousness or a sense of being watched. This is especially for people with body-image concerns or heightened anxiety in public.

Work on playful urban objects and large public displays emphasizes the need for "soft invitations" and easy opt-out paths: people should be able to approach, observe, and disengage without social penalty. Our findings reinforce this from a mirror-based perspective. When reflections appear in one's direct line of sight without framing, as in *Mirror-only*, participants sometimes reported "awkward… suddenly making eye contact through the mirror" and chose to avoid looking. By contrast, when the mirror was clearly attached to a moving agent with a visible arc of approach and departure, people were more likely to treat the experience as a playful event they could join or ignore.

Designing with mirrors requires sensitivity. In some contexts, especially where people feel physically exposed or are managing body-image or mental-health concerns, surprise mirrors can reasonably be experienced as intrusive rather than delightful. Designers should therefore treat mirrors not as neutral infrastructure, but as socially charged objects that can either lower or raise social barriers depending on how they are placed, animated, and explained.

As such, mirrors could be designed with considerations of (1) framing: Slow movements and brief "glance" moments rather than long, fixed reflections to signal playful, time-bounded interaction, not surveillance; (2) optional looking: positioning mirrors slightly off-axis instead of where people have to see it, allowing people to choose whether to enter the reflected field; (3) alternative focal elements: Combining mirrors with other kinetic or visual elements can give people routes into participation without having to only focusing on the mirror.

Finally, playful mirrors may be welcome in some low-stakes, socially framed settings (e.g., lounges, networking mixers, museums) and inappropriate in others where people feel exposed or vulnerable (e.g., medical waiting rooms, security lines). Urban probes and ludic technologies have long argued for working with the grain of a site's existing social practices; mirrors add another layer, because they interact directly with how people see themselves.

6.3 Design Implications for Ice-Breaking Technologies

Finally, in light of the insights into interactions between strangers, three further considerations for designing future ice-breaking technologies emerge: knowing when to exit, facilitating rather than performing, and treating ambiguity as a resource.

6.3.1 *Knowing When to Withdraw.*

We note that while some participants reported sustained engagement, others described emotional closeness as momentary, tied to the novelty of the robot or fleeting social cues. Echoing challenges noted in prior ambient interventions [7, 17], not all attention is welcome. For instance, P123 noted they felt connected while observing the other using their phone to record the robot, but that "the novelty wore off later." Some participants valued the "chill" quietness of the Control condition (P412) or wanted interventions to remain optional (*"I would not want to bother strangers in an airport,"* P123). In designing for ice-breaking, the timing and how long the intervention should stay are nuanced calibrations to take into consideration.

It reminds us that future systems should provide opt-out paths and context-aware timing. Designers should consider adding low-effort ways for users to ignore or suspend the system, and keep an interpersonal distance buffer. Interventions should invite co-interpretation, not leave people unsure if they are being judged or recorded [29].

6.3.2 *Facilitating Rather Than Performing.*

One of the interesting findings was that participants rated the Bot-only robot as more emotionally expressive and socially interested than *MirrorBot*. This result highlights a trade-off also observed in prior HRI work: robots that act as expressive performers (e.g., humorous robots in Press et al. [81]) may be engaging but risk dominating the interaction. Without mirrors, the robot itself became the main object of attention, and its gestures were interpreted as

agentic or intentional. By contrast, *MirrorBot* redirected people's attention away from the robot itself and toward each other. As one participant explained, *"When we are both looking at the robot… we're seeing each other"* (P120). In this way, *MirrorBot* functioned more as a facilitator of human–human interaction than as a social actor in its own right.

This distinction underscores an important design trade-off. Robots that demand to be read as expressive agents may appear more "social," but they can also compete with human–human exchange. Robots that recede into the background may be seen as less social, yet be more effective facilitators. Prior HRI studies show that perceptions of robot socialness are tightly coupled to where attention is directed [58, 103]. Our findings extend this work by showing that a robot can be most socially useful when it is not the center of social meaning, but instead reshapes the interactional field so people can notice each other. Socially effective robots may be those that recede, orchestrating the social stage for people, rather than occupying its spotlight.

6.3.3 ***Ambiguity as a Design Resource***.

MirrorBot's ambiguous behaviors, unclear purpose, and shifting reflections—provided just enough uncertainty to spark curiosity and shared interpretation. This aligns with Gaver's notion of ambiguity as a resource in design [29]: cues that are open-ended invite co-interpretation, giving people a "shared puzzle" to negotiate meaning together. Unlike more explicit interventions that prescribe posture or conversation prompts for interaction [102], *MirrorBot* invited strangers to negotiate meaning together: *"we were both just looking at each other… what the heck is going on?"* (P108). This interpretive openness transformed a puzzling moment into a shared discovery.

However, ambiguity must be carefully calibrated, as too much ambiguity can feel intrusive or confusing. Jerky movements were described as "attention-grabbing" (P108), and unexplained reflections sometimes tipped into discomfort or surveillance (*"like they are staring at you without actually staring at you,"* P407). The design challenge, then, is to sustain enough ambiguity to invite engagement and joint sense-making, while providing subtle timing and framing cues that make looking and acknowledging feel socially safe.

7 Limitation and Future Work

The primary limitation of the study lies in its ecological validity. The experiment was conducted in a controlled laboratory setting with a relatively small number of participants, raising questions about the generalizability of the findings to real-world contexts. For instance, in settings such as airport waiting areas, where people often disengage from their surroundings, capturing attention may be considerably more challenging. Unpredictable pedestrian flows could also alter the rhythm of eye contact between strangers, potentially leading to entirely new interaction dynamics. A field study would therefore be a valuable next step. Since *MirrorBot* is designed for low-stakes social encounters, another further step is to deploy it in specific contexts, such as structured but socially charged situations, such as speed-dating events, networking mixers, or onboarding sessions, to examine how robust these effects are when people have stronger goals and expectations of social interaction.

A second limitation lies in our condition design and what it allows us to infer about the relative roles of the robot body and the mirrors. Including both a Mirror-only and a Robot-only condition helped separate "having a mirror" from "having a robot," but the comparison is not perfectly clean: the mirrors in the *MirrorBot* condition were dynamic and responsive, whereas the mirrors in the Mirror-only condition were static wall fixtures. Any differences between these two conditions therefore conflate mirror motion, robot embodiment, and their combination. We did not include a condition with moving mirrors but no mobile base, nor a condition where the robot was present but the mirrors remained stationary. This means we cannot determine from our data whether the observed effects are driven primarily by the moving mirrors, the presence of the robot, or their integration. Future work should more fully factor these elements, for example, by comparing (1) a mobile robot with static mirrors, (2) a non-robotic dynamic mirror installation, and (3) the integrated *MirrorBot* design.

A third limitation concerns our implementation and control policy. In this study, *MirrorBot*'s navigation and switches of mirror states were teleoperated, and we used a single hand-crafted sequence for mirror repositioning and eye-contact timing. This limits autonomy and makes it difficult to identify which aspects of the policy (e.g., frequency of switches, length of joint-reflection episodes, timing of appearance and exit) were most important. Future studies could systematically manipulate these parameters and move toward autonomous policies that infer, from posture, mutual orientation, and ongoing activity, when to approach, when to remain in the periphery, and when to withdraw.

A fourth limitation concerns individual differences. We report correlations between outcome measures and personality traits as exploratory results in Appendix G. However, examining the moderation effects of individual differences would require a larger sample to be adequately powered. We therefore identify systematic tests of how personality or other traits moderate *MirrorBot*'s effects as an important direction for future work.

Finally, participants encountered *MirrorBot* under a one-shot cover story about a memory task, with no prior knowledge that the robot was designed to foster social interaction. As the system becomes publicly deployed, people may come to understand its function and anticipate its behavior. Would they still feel more connected if they knew *MirrorBot*'s mission was to foster social interaction, or would the experience feel staged and artificial? Exploring these questions is crucial for designing social robots that mediate authentic and meaningful connections.

8 Conclusion

Overall, *MirrorBot* produced greater ease and lower awkwardness in initiating interaction, higher levels of interpersonal closeness, stronger feelings of togetherness, and more enjoyable experiences compared with the other conditions. Mirror-only consistently yielded the lowest ratings of closeness and overall interaction quality, possibly due to the stronger spotlighting effect of a static mirror. Interestingly, Bot-only was perceived as more expressive or social than *MirrorBot*, suggesting a tradeoff in which systems that facilitate human-to-human connection may be perceived as less social themselves when attention is redirected toward the partner rather than

the robot. These findings raise broader questions about how robots should be designed to support ice-breaking among strangers, and we discussed what roles they can or should play in such fleeting dynamics.

Our work contributes empirical evidence for the efficacy of a mobile robotic mirror system in facilitating interaction between strangers. We present an instance of such a system through *MirrorBot*, which leverages the symbolic and interactive affordances of mirrors to create opportunities for social connection in public settings. Finally, we contribute design implications for HRI and HCI by highlighting how the roles that robots adopt in strangers' encounters must be carefully crafted to balance mediation, subtlety, and social perception.

Acknowledgments

We thank our research assistants Alif Abdullah, Miriam Alex, and Jay Zheng for their contributions to the technical development of the mirror algorithm. We thank Xiaoman Yang for developing the mirror's mechanical mechanism and assisting with graphics and video production. We thank Allen Wu for developing the vision–language model pipeline for the project. We also thank Penny Ren, Daniel Lee, Huong Pham, and Simone Jacobs for their invaluable help in conducting the user studies. We are grateful to Professor Malte Jung for his advice on the project. Finally, we thank the reviewers for their thoughtful suggestions, which greatly helped improve this paper.

References

[1] Daniel C Albas and Cheryl A Albas. 1989. Meaning in context: The impact of eye contact and perception of threat on proximity. *The Journal of social psychology* 129, 4 (1989), 525–531.

[2] Irwin Altman and Dalmas Taylor. 1973. *Social Penetration: The Development of Interpersonal Relationships*. Holt, Rinehart and Winston.

[3] Michael Argyle and Janet Dean. 1965. Eye-contact, distance and affiliation. *Sociometry* (1965), 289–304.

[4] Arthur Aron, Elaine N Aron, and Danny Smollan. 1992. Inclusion of other in the self scale and the structure of interpersonal closeness. *Journal of personality and social psychology* 63, 4 (1992), 596.

[5] Arthur Aron, Edward Melinat, Elaine N Aron, Robert Darrin Vallone, and Renee J Bator. 1997. The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Personality and social psychology bulletin* 23, 4 (1997), 363–377.

[6] Kai O Arras and Daniela Cerqui. 2005. Do we want to share our lives and bodies with robots? A 2000 people survey: a 2000-people survey. *Technical report* 605 (2005).

[7] Mara Balestrini, Paul Marshall, Raymundo Cornejo, Monica Tentori, Jon Bird, and Yvonne Rogers. 2016. Jokebox: Coordinating Shared Encounters in Public Spaces. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (San Francisco, California, USA) *(CSCW '16)*. Association for Computing Machinery, New York, NY, USA, 38–49. doi:10.1145/2818048.2835203

[8] Zygmunt Bauman. 1995. *Life in Fragments: Essays in Postmodern Morality*. Blackwell. https://philpapers.org/rec/BAULIF

[9] Roy F Baumeister and Mark R Leary. 1995. The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological bulletin* 117, 3 (1995), 497–529. doi:10.1037/0033-2909.117.3.497

[10] Ellen Berscheid, Mark Snyder, and Allen M Omoto. 1989. The Relationship Closeness Inventory: Assessing the closeness of interpersonal relationships. *Journal of personality and Social Psychology* 57, 5 (1989), 792.

[11] Marco Bertamini, Letizia Palumbo, Tamara Nicoleta Gheorghes, and Mai Galatsidas. 2016. Do observers like curvature or do they dislike angularity? *British Journal of Psychology* 107, 1 (2016), 154–178.

[12] Frank Biocca, Judee Burgoon, Chad Harms, Matt Stoner, et al. 2001. Criteria and scope conditions for a theory and measure of social presence. *Presence: Teleoperators and virtual environments* (2001).

[13] Frank Biocca, Chad Harms, and Judee K Burgoon. 2003. Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & virtual environments* 12, 5 (2003), 456–480.

[14] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative research in psychology* 3, 2 (2006), 77–101.

[15] Cynthia L. Breazeal. 2002. *Designing Sociable Robots*. MIT Press.

[16] Harry Brignull and Yvonne Rogers. 2003. Enticing people to interact with large public displays in public spaces.. In *Interact*, Vol. 3. 17–24.

[17] Barry Brown, Fanjun Bu, Ilan Mandel, and Wendy Ju. 2024. Trash in Motion: Emergent Interactions with a Robotic Trashcan. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI '24)*. Association for Computing Machinery, New York, NY, USA, Article 591, 17 pages. doi:10.1145/3613904.3642610

[18] Judee K Burgoon and Jerold L Hale. 1987. Validation and measurement of the fundamental themes of relational communication. *Communications Monographs* 54, 1 (1987), 19–41.

[19] Graham Button and Neil Casey. 1984. Generating topic: The use of topic initial elicitors. *Structures of social action: Studies in conversation analysis* 167 (1984), 190.

[20] Colleen M. Carpinella, Alisa B. Wyman, Michael A. Perez, and Steven J. Stroessner. 2017. The Robotic Social Attributes Scale (RoSAS): Development and Validation. In *2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. 254–262.

[21] Lewis Carroll, David Horovitch, and Jo Wyatt. 2020. *Through the looking Glass and what Alice Found there*. Naxos Audiobooks.

[22] Herbert H Clark. 1996. *Using language*. Cambridge university press.

[23] Brian R. Duffy. 2003. Towards Social Intelligence in Autonomous Robotics: A Review. *Robotics, Distance Learning and Intelligent Communication Systems (RODLICS)* (2003), 1–16.

[24] Nicholas Epley and Juliana Schroeder. 2014. Mistakenly seeking solitude. *Journal of Experimental Psychology: General* 143, 5 (2014), 1980.

[25] Ylva Ferstl, Elena Kokkinara, and Rachel McDonnell. 2016. Do I trust you, abstract creature? A study on personality perception of abstract virtual faces. In *Proceedings of the ACM Symposium on Applied Perception*. 39–43.

[26] Terrence Fong, Illah Nourbakhsh, and Kerstin Dautenhahn. 2003. A survey of socially interactive robots. *Robotics and Autonomous Systems* 42, 3–4 (2003), 143–166.

[27] Benediktas Gylys Foundation. 2025. Portals: Bridge to a United Planet. https://www.portals.org/. Accessed: 2025-12-01.

[28] Moya Fraser, Zoraida Callejas, Howard Jones, Astrid Weiss, and Kerstin Dautenhahn. 2022. Perceptions of robot social attributes in a public space. In *Proceedings of the 2022 ACM/IEEE International Conference on Human-Robot Interaction*. IEEE, 281–290.

[29] William W Gaver, Jacob Beaver, and Steve Benford. 2003. Ambiguity as a resource for design. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 233–240.

[30] William W Gaver, John Bowers, Andrew Boucher, Hans Gellerson, Sarah Pennington, Albrecht Schmidt, Anthony Steed, Nicholas Villars, and Brendan Walker. 2004. The drift table: designing for ludic engagement. In *CHI'04 extended abstracts on Human factors in computing systems*. 885–900.

[31] Erving Goffmann. 1963. *Behavior in public places: Notes on the social organization of gatherings*. Greenwood Press.

[32] Samuel D Gosling, Peter J Rentfrow, and William B Swann Jr. 2003. A very brief measure of the Big-Five personality domains. *Journal of Research in personality* 37, 6 (2003), 504–528.

[33] Gerald W Grumet. 1983. Eye contact: The core of interpersonal relatedness. *Psychiatry* 46, 2 (1983), 172–180.

[34] Gul Gunaydin, Hazal Oztekin, Deniz Hazal Karabulut, and Selin Salman-Engin. 2021. Minimal Social Interactions with Strangers Predict Greater Subjective Well-Being. *Journal of happiness studies* 22, 4 (April 2021), 1839–1853. doi:10.1007/s10902-020-00298-6

[35] Ge Guo, Gilly Leshed, and Keith Evan Green. 2023. "I normally wouldn't talk with strangers": Introducing a Socio-Spatial Interface for Fostering Togetherness Between Strangers. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg, Germany) *(CHI '23)*. Association for Computing Machinery, New York, NY, USA, Article 272, 20 pages. doi:10.1145/3544548.3581325

[36] Ge (Serena) Guo. 2025. Designing Socio-Spatial Interfaces for Embodied and Situated Social Interaction. In *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '25)*. Association for Computing Machinery, New York, NY, USA, Article 849, 6 pages. doi:10.1145/3706599.3721093

[37] Ge (Serena) Guo, Qi Yang, Yunting Yan, Xiaoman Yang, Guy Hoffman, Gilly Leshed, and Keith Evan Green. 2025. MirrorBot: Exploring Socio-Spatial Interactions that Foster Serendipitous Human Connections Through Robotic Mirrors. In *Proceedings of the Extended Abstracts of the CHI Conference on Human Factors in Computing Systems (CHI EA '25)*. Association for Computing Machinery, New York, NY, USA, Article 736, 6 pages. doi:10.1145/3706599.3721176

[38] Serena Ge Guo, Hsin-Ming Chao, Huong Pham, Gilly Leshed, and Keith Evan Green. 2025. Unraveling Strangers' Interaction: An Analytical Framework for

Understanding the Ice-Breaking Process with a Socio-Spatial Interface. *ACM Trans. Comput.-Hum. Interact.* 32, 5, Article 47 (Oct. 2025), 38 pages. doi:10.1145/3742857

[39] Serena Ge Guo, Jenny Yu, Wenqian Niu, Yifei Gao, Guy Hoffman, Gilly Leshed, and Keith Evan Green. 2026. Robot-Mediated Mutual Gaze: How a Mobile Robot with Actuated Mirrors Facilitates Encounters between Strangers. In *Proceedings of the 21st ACM/IEEE International Conference on Human-Robot Interaction* (Edinburgh, Scotland Uk) *(HRI '26)*. IEEE Press. doi:10.1145/3757279.3785647

[40] Chad Harms and Frank Biocca. 2004. Internal consistency and reliability of the networked minds measure of social presence. (2004).

[41] Elaine Hatfield, John T Cacioppo, and Richard L Rapson. 1993. Emotional contagion. *Current directions in psychological science* 2, 3 (1993), 96–100.

[42] Luke Hespanhol, Martin Tomitsch, Oliver Bown, and Miriama Young. 2014. Using embodied audio-visual interaction to promote social encounters around large media façades. In *Proceedings of the 2014 conference on Designing interactive systems* (Vancouver, BC, Canada) *(DIS '14)*. Association for Computing Machinery, New York, NY, USA, 945–954. doi:10.1145/2598510.2598568

[43] Guy Hoffman, Or Zuckerman, Gilad Hirschberger, Michal Luria, and Tal Shani Sherman. 2015. Design and Evaluation of a Peripheral Robotic Conversation Companion. In *Proceedings of the 10th ACM/IEEE International Conference on Human-Robot Interaction*. ACM, 3–10. doi:10.1145/2696454.2696495

[44] Rob W Holland, Ute-Regina Roeder, Baaren Rick B. van, Aafje C Brandt, and Bettina Hannover. 2004. Don't stand so close to me: The effects of self-construal on interpersonal closeness. *Psychological science* 15, 4 (2004), 237–242.

[45] Richard Hovey and Helen Massfeller. 2012. Exploring the relational aspects of patient and doctor communication. *Journal of medicine and the person* 10, 2 (Aug. 2012), 81–86. doi:10.1007/s12682-012-0123-0

[46] Lee Humphreys. 2005. Cellphones in public: social interactions in a wireless era. *New Media & Society* 7, 6 (Dec. 2005), 810–833. doi:10.1177/1461444805058164

[47] Jihong Hwang, Taezoon Park, and Wonil Hwang. 2013. The effects of overall robot shape on the emotions invoked in users and the perceived personalities of robot. *Applied ergonomics* 44, 3 (2013), 459–471.

[48] Rachel Jacobs, Holger Schnädelbach, Nils Jäger, Silvia Leal, Robin Shackford, Steve Benford, and Roma Patel. 2019. The Performative Mirror Space. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, New York, NY, USA. doi:10.1145/3290605.3300630

[49] Malte Jung, Nathan Martelaro, and Pamela Hinds. 2015. Using Robots to Moderate Team Conflict: The Case of Repairing Violations. In *Proceedings of the 10th ACM/IEEE International Conference on Human-Robot Interaction*. ACM, 229–236. doi:10.1145/2696454.2696460

[50] Michael Kardas, Amit Kumar, and Nicholas Epley. 2022. Overly shallow?: Miscalibrated expectations create a barrier to deeper conversation. *Journal of personality and social psychology* 122, 3 (2022), 367.

[51] Jenny Kennedy, Paul Baxter, and Tony Belpaeme. 2017. A comparative study of the impact of robot affect on human trust during a navigation task. In *Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction*. ACM, 57–64.

[52] Ashraf Khalil, Soha Glal Ahmed, Asad Masood Khattak, and Nabeel Al-Qirim. 2020. Investigating bias in facial analysis systems: A systematic review. *IEEE Access* 8 (2020), 130751–130761.

[53] Sofie Kinch, Erik Grönvall, Marianne Graves Petersen, and Majken Kirkegaard Rasmussen. 2014. Encounters on a shape-changing bench: exploring atmospheres and social behaviour in situ. In *Proceedings of the 8th International Conference on Tangible, Embedded and Embodied Interaction* (Munich, Germany) *(TEI '14)*. Association for Computing Machinery, New York, NY, USA, 233–240. doi:10.1145/2540930.2540947

[54] Chris L Kleinke. 1986. Gaze and eye contact: a research review. *Psychological bulletin* 100, 1 (1986), 78.

[55] Hannu Korhonen, Markus Montola, and Juha Arrasvuori. 2009. Understanding playful user experience through digital games. In *International conference on designing pleasurable products and interfaces*, Vol. 2009. Compiegne, 13–16.

[56] Peter Gall Krogh, Marianne Graves Petersen, Kenton O'Hara, and Jens Emil Groenbaek. 2017. Sensitizing Concepts for Socio-spatial Literacy in HCI. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (Denver, Colorado, USA) *(CHI '17)*. Association for Computing Machinery, New York, NY, USA, 6449–6460. doi:10.1145/3025453.3025756

[57] Jacques Lacan. 1936. The mirror stage as formative of the function of the I as revealed in psychoanalytic experience 1. In *Reading French Psychoanalysis*. Routledge, 97–104.

[58] Kwan Min Lee, Namkee Park, and Hayeon Song. 2005. Can a robot be perceived as a developing creature? Effects of a robot's long-term cognitive developments on its social presence and people's social responses toward it. *Human communication research* 31, 4 (2005), 538–563.

[59] Wen-Ying Lee, Yoyo Tsung-Yu Hou, Cristina Zaga Human, and Malte Jung. 2020. Design for serendipitous interaction: BubbleBot - bringing people together with bubbles. In *Proceedings of the 14th ACM/IEEE International Conference on Human-Robot Interaction* (Daegu, Republic of Korea) *(HRI '19)*. IEEE Press, 759–760.

[60] Dingjun Li, PL Patrick Rau, and Ye Li. 2010. A cross-cultural study: Effect of robot appearance and task. *International Journal of Social Robotics* 2 (2010), 175–186.

[61] Ela Liberman-Pincu, Yisrael Parmet, and Tal Oron-Gilad. 2023. Judging a socially assistive robot by its cover: the effect of body structure, outline, and color on users' perception. *ACM Transactions on Human-Robot Interaction* 12, 2 (2023), 1–26.

[62] Cedric Liu, Bilge Mutlu, and Michael Gleicher. 2022. Expressive robot motion timing reveals human-like social attributes. In *Proceedings of the 2022 ACM/IEEE International Conference on Human-Robot Interaction*. IEEE, 15–24.

[63] Katherine A Loveland. 1986. Discovering the affordances of a reflecting surface. *Developmental Review* 6, 1 (1986), 1–24. doi:10.1016/0273-2297(86)90001-8

[64] Andrés Lucero, Jussi Holopainen, Elina Ollila, Riku Suomela, and Evangelos Karapanos. 2013. The playful experiences (PLEX) framework as a guide for expert evaluation. In *Proceedings of the 6th international conference on designing pleasurable products and interfaces*. 221–230.

[65] Diego Martinez Plasencia, Florent Berthaut, Abhijit Karnik, and Sriram Subramanian. 2014. Through the combining glass. In *Proceedings of the 27th annual ACM symposium on User interface software and technology*. ACM, New York, NY, USA. doi:10.1145/2642918.2647351

[66] Debra J Mashek, Arthur Aron, and Maria Boncimino. 2003. Confusions of self with close others. *Personality and Social Psychology Bulletin* 29, 3 (2003), 382–392.

[67] Gabrielle M Maxwell, Michael W Cook, and Raymond Burr. 1985. The encoding and decoding of liking from behavioral cues in both auditory and visual channels. *Journal of Nonverbal Behavior* 9 (1985), 239–263.

[68] Joslin McKinney. 2009. The Cambridge Introduction to Scenography. *Cambridge UP* (2009).

[69] R Matthew Montoya and Robert S Horton. 2013. A meta-analytic investigation of the processes underlying the similarity-attraction effect. *Journal of social and personal relationships* 30, 1 (2013), 64–94.

[70] Masahiro Mori, Karl F MacDorman, and Norri Kageki. 2012. The uncanny valley [from the field]. *IEEE Robotics & automation magazine* 19, 2 (2012), 98–100.

[71] Bilge Mutlu, Takayuki Shiwa, Takayuki Kanda, Hiroshi Ishiguro, and Norihiro Hagita. 2009. Footing in Human-Robot Conversations: How Robots Might Shape Participant Roles Using Gaze Cues. In *Proceedings of the 4th ACM/IEEE International Conference on Human-Robot Interaction*. ACM, 61–68. doi:10.1145/1514095.1514113

[72] Karynna Okabe-Miyamoto, Lisa C Walsh, Daniel J Ozer, and Sonja Lyubomirsky. 2024. Measuring the experience of social connection within specific social interactions: The Connection During Conversations Scale (CDCS). *Plos one* 19, 1 (2024), e0286408.

[73] Sofia Pantouvaki. 2020. (Re) performing scenography: Josef Svoboda as a tutor. *Theatre and Performance Design* 6, 3 (2020), 199–220.

[74] Forster + Partners. 2013. *Marseille Vieux Port*. https://www.fosterandpartners.com/projects/marseille-vieux-port

[75] Miles L Patterson. 1995. Invited article: A parallel process model of nonverbal communication. *Journal of Nonverbal Behavior* 19, 1 (1995), 3–29.

[76] Peter Peltonen, Esko Kurvinen, Antti Salovaara, Giulio Jacucci, Tommi Ilmonen, John Evans, Antti Oulasvirta, and Petri Saarikko. 2008. It's Mine, Don't Touch! interactions at a large multi-touch display in a city centre. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Florence, Italy) *(CHI '08)*. Association for Computing Machinery, New York, NY, USA, 1285–1294. doi:10.1145/1357054.1357255

[77] Anat Perry, David Mankuta, and Simone G Shamay-Tsoory. 2015. OT promotes closer interpersonal distance among highly empathic individuals. *Social cognitive and affective neuroscience* 10, 1 (2015), 3–9.

[78] Manfred Pfister. 1988. The theory and analysis of drama. *Cambridge UP* (1988).

[79] Richard Pieper. 2022. *Manet and the Mirror – A Bar at the Folies-Bergère (P25)*. https://mymanet.net/home/2022/02/14/elementor-1997/

[80] Sylvia Plath. 2017. *Poem "Mirror" in Crossing the water*. Faber & Faber.

[81] Viva Sarah Press and Hadas Erel. 2023. Humorous Robotic Behavior as a New Approach to Mitigating Social Awkwardness. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (Hamburg, Germany) *(CHI '23, Article 427)*. Association for Computing Machinery, New York, NY, USA, 1–16. doi:10.1145/3544548.3580821

[82] Byron Reeves, Jeff Hancock, et al. 2020. Social robots are like real people: First impressions, attributes, and stereotyping of social robots. (2020).

[83] Harry T Reis, Michael R Maniaci, Peter A Caprariello, Paul W Eastwick, and Eli J Finkel. 2011. Familiarity does indeed promote attraction in live interaction. *Journal of personality and social psychology* 101, 3 (2011), 557.

[84] Danielle Rifinski, Hadas Erel, Adi Feiner, Guy Hoffman, and Oren Zuckerman. 2021. Human-human-robot interaction: robotic object's responsive gestures improve interpersonal evaluation in human interaction. *Human–Computer Interaction* 36, 4 (2021), 333–359.

[85] Horst WJ Rittel and Melvin M Webber. 1973. Dilemmas in a general theory of planning. *Policy sciences* 4, 2 (1973), 155–169.

[86] Nicolas Roussel, Helen Evans, and Heiko Hansen. 2004. MirrorSpace: Using proximity as an interface to video-mediated communication. In *Lecture Notes in Computer Science*. Springer Berlin Heidelberg, Berlin, Heidelberg, 345–350. doi:10.1007/978-3-540-24646-6_25

[87] Ofir Sadka, Alon Jacobi, Andrey Grishko, Udi Lumnitz, Benny Megidish, and Hadas Erel. 2022. "By the way, what's your name?": The Effect of Robotic Bar-stools on Human-human Opening-encounters. In *Extended Abstracts of the 2022 CHI Conference on Human Factors in Computing Systems* (New Orleans, LA, USA) *(CHI EA '22)*. Association for Computing Machinery, New York, NY, USA, Article 331, 6 pages. doi:10.1145/3491101.3519726

[88] Andrea C. Samson, Sylvia D. Kreibig, Blake Soderstrom, A. Ayanna Wade, and James J. Gross and. 2016. Eliciting positive, negative and mixed emotional states: A film library for affective scientists. *Cognition and Emotion* 30, 5 (2016), 827–856. arXiv:https://doi.org/10.1080/02699931.2015.1031089 doi:10.1080/02699931.2015.1031089 PMID: 25929696.

[89] Gillian M Sandstrom and Erica J Boothby. 2021. Why do people avoid talking to strangers? A mini meta-analysis of predicted fears and actual experiences talking to a stranger. *Self and Identity* 20, 1 (2021), 47–71.

[90] Gillian M Sandstrom and Elizabeth W Dunn. 2014. Social Interactions and Well-Being: The Surprising Power of Weak Ties. *Personality & social psychology bulletin* 40, 7 (July 2014), 910–922. doi:10.1177/0146167214529799

[91] Laurie Schneider. 1985. Mirrors in art. *Psychoanalytic Inquiry* 5, 2 (1985), 283–324.

[92] Atsushi Senju and Mark H Johnson. 2009. The eye contact effect: mechanisms and development. *Trends in cognitive sciences* 13, 3 (2009), 127–134.

[93] R d Shaver and P Reis. 1988. *Intimacy as an interpersonal process*. USA.

[94] Garriy Shteynberg. 2015. Shared attention. *Perspectives on psychological science* 10, 5 (2015), 579–590.

[95] Daniel Szafir and Bilge Mutlu. 2012. Pay attention! designing adaptive agents that monitor and improve user engagement. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Austin, Texas, USA) *(CHI '12)*. Association for Computing Machinery, New York, NY, USA, 11–20. doi:10.1145/2207676.2207679

[96] Henry Tennent, Siyang Shen, and Malte Jung. 2019. Micbot: A Peripheral Robotic Object to Shape Conversational Dynamics and Team Performance. In *Proceedings of the 14th ACM/IEEE International Conference on Human-Robot Interaction*. IEEE, 133–142. doi:10.1109/HRI.2019.8673300

[97] Keita Ushida, Yu Tanaka, Takeshi Naemura, and Hiroshi Harashima. 2002. i-mirror: An interaction/information environment based on a mirror metaphor aiming to install into our life space. In *Proceedings of the 12th International Conference on Artificial Reality and Telexistence (ICAT2002)*. 113–118.

[98] Paul A M Van Lange and Simon Columbus. 2021. Vitamin S: Why Is Social Contact, Even With Strangers, So Important to Well-Being? *Current directions in psychological science* 30, 3 (June 2021), 267–273. doi:10.1177/09637214211002538

[99] Michael Von Grünau and Christina Anston. 1995. The detection of gaze direction: A stare-in-the-crowd effect. *Perception* 24, 11 (1995), 1297–1313.

[100] James R Wallace, Nancy Iskander, and Edward Lank. 2016. Creating your bubble: Personal space on and around large public displays. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. 2087–2092.

[101] Mark Weiser and John Seely Brown. 1996. Designing calm technology. *PowerGrid Journal* 1, 1 (1996), 75–85.

[102] Alex Wuqi Zhang, Ting-Han Lin, Xuan Zhao, and Sarah Sebo. 2023. Ice-breaking technology: Robots and computers can foster meaningful connections between strangers through in-person conversations. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. 1–14.

[103] Jakub Złotowski, Diane Proudfoot, Kumar Yogeeswaran, and Christoph Bartneck. 2015. Anthropomorphism: opportunities and challenges in human–robot interaction. *International journal of social robotics* 7, 3 (2015), 347–360.

APPENDIX

A Survey Measures

A.1 Social Presence Scale

Subscale	Item
Co-presence	I was often aware of the other participant's presence.
Co-presence	I could tell the other participant was often aware of my presence.
Attentional Allocation	We were both attending to the same thing.
Attentional Allocation	I could tell that the other participant was interacting with me.
Perceived Message Understanding	My thoughts were clear to the other participant.
Perceived Message Understanding	The other participant's thoughts were clear to me.
Perceived Affective Understanding	I could tell how the other participant felt.
Perceived Affective Understanding	The other participant could tell how I felt.

A.2 Relational Communication Scale (RCS)

Subscale	Item
Immediacy / Affection	The other participant seemed warm and friendly.
Similarity / Depth	The other participant seemed relatable.
Receptivity / Trust	The other participant seemed open to social interaction.
Composure	I felt a sense of ease being around this person.
Composure	I believe the other participant was comfortable around me.

A.3 Human–Human Liking Scale

Subscale	Item
–	I felt that the other participant liked me.
–	I would enjoy spending more time with the other participant.
–	I would be happy to talk with this person again in a different setting.
–	I felt connected to the other participant.

A.4 Connection During Conversations Scale

Subscale	Item
Shared Reality	I felt "in sync" with the other participant.
Partner Responsiveness	The other participant was interested in my thoughts and feelings.
Partner Responsiveness	I felt that the other participant cared about me.
Participant Interest	I was truly attentive during the interaction.
Participant Interest	I was interested in the other participant's thoughts and feelings.
Participant Interest	I thought that our conversation was boring.
Participant Interest	I was distracted during the conversation.
Affective Experience	I was nervous during the interaction.
Affective Experience	I felt that my energy was drained by the interaction.
Affective Experience	I couldn't wait for the interaction to end.
Affective Experience	I felt that it was hard to communicate with the other participant.

A.5 Overall Interaction Experience

Subscale	Item
-	How happy do you feel about your interaction?
-	How awkward do you feel about your interaction?
-	How uncomfortable was the interaction?
-	How enjoyable was the interaction?
-	How vulnerable did you feel during the interaction?

A.6 Initiating a Conversation

Subscale	Item
-	I would feel awkward to start the conversation.
-	I would feel uncomfortable to start the conversation.
-	I would feel easy to start the conversation.
-	I would feel vulnerable to start the conversation.

A.7 Robotic Social Attributes Scale (RoSAS)

Subscale	Item
Warmth	The robot appears to have feelings.
Warmth	The robot seems happy.
Warmth	The robot seems natural or lifelike.
Warmth	The robot seems compassionate.
Warmth	The robot seems interested in interacting with people.
Warmth	The robot shows or expresses emotions.
Discomfort	The robot made me feel scary.
Discomfort	The robot made me feel awkward.
Discomfort	The robot made me feel strange.
Discomfort	The robot is annoying.

B Semi-Structured Interview Questions

Below is the semi-structured interview protocol used after the 10-minute waiting-room period. Questions were adapted slightly across conditions, as indicated below.

B.1 Waiting-Room Experience (All Conditions)

(1) How did you feel about the waiting-room experience?
(2) What, if anything, triggered you to start a conversation — or to decide not to talk?
(3) Do you recall what you talked about?
(4) Who initiated the interaction? You or the other person?

B.2 Experience of Mirrors and Gaze

MirrorBot and Mirror-only:

(1) Did you notice seeing yourself in the mirror(s)? How did that make you feel?
(2) Did you notice the other participant in the mirror(s)? How did that make you feel?
(3) Did you feel that you had eye contact with the other participant — either directly or through the mirror(s)?
  (a) If yes: Can you describe what that was like?
(4) Did the mirrors affect how you behaved?

Control:

- Did you have any eye contact with the other participant? If so, how did that feel?

B.3 Robot Presence and Its Role (*MirrorBot* and Bot-only)

(1) Did you notice the robot when it entered? What was your first reaction?
(2) What do you think the robot was doing or trying to do in the waiting room?
(3) What do you think was the role of the robot in your dynamic with the other participant?
(4) Did your feelings about the experience change over time while the robot was present? If so, how?
(5) What do you think of the other participant in your session?
  (a) Did you feel there was any sense of connection between you and the other participant? If yes, when did you feel it most?
(6) Can you use three words to describe the robot?

(7) Imagine that this robot is deployed in a public space to help connect two strangers. How would you feel about that? How do you imagine such a scenario unfolding?

B.4 General Attitudes Toward Interacting With Strangers (All Conditions)

(1) Do you think it is necessary or important to interact with strangers in everyday life? Why or why not?
(2) Do you feel there are any benefits to interacting with strangers?
  (a) (If needed) Would a brief smile or saying "hi" count as a benefit to you?
(3) Can you recall any pleasant past experience you have had interacting with a stranger? Please describe it.

B.5 Debrief and Reactions to the Design (All Conditions)

After revealing the true purpose of the study and, when appropriate, showing a short video of the *MirrorBot* scenario, we asked:

(1) Now that you know more about the study, how do you feel about the design you just saw or experienced?
(2) How do you feel about using mirrors as a method to create mutual attention between strangers?
(3) If you were one of the people in the video scenario, how do you think you would react?
(4) If you had "magic powers" and did not need to worry about technical limitations or feasibility, how would you improve this design?
(5) Are there aspects of this design that you particularly like or dislike? Why?

B.6 Ideas for Future Ice-Breaking Technologies (All Conditions)

(1) Do you think technologies that help strangers break the ice are necessary or useful? Why or why not?
(2) Can you think of any technologies that could facilitate connections between two strangers in a setting like this?
  (a) These could be robots, screens, interactive installations, or something else.
(3) Can you think of non-technological ways or examples that could help two strangers feel more comfortable or connected in a situation like this?

C Descriptive Statistics of Personality Traits Across the Four Conditions

Table 1: Mean (SD) of personality traits by condition.

Condition	Enthusiastic	Openness	Quietness
MirrorBot	4.62 (1.41)	5.75 (1.03)	3.67 (1.34)
Bot-only	4.50 (1.20)	5.78 (1.00)	4.56 (1.46)
Mirror-only	4.61 (1.58)	5.89 (0.76)	4.22 (1.48)
Control	5.15 (1.50)	5.80 (0.83)	4.10 (1.52)

D Descriptive and Inferential Statistics of All Survey Measures

Table 2: Descriptive statistics and mixed-effects model p-values for the Connection During Conversations Scale (CDCS).

Item	Condition	M	SD	95% CI	p
Affective Experience	*MirrorBot*	22.333	4.488	[20.538, 24.128]	
	Bot-only	17.833	3.792	[16.081, 19.585]	0.00479
	Mirror-only	19.667	5.064	[17.327, 22.007]	0.0832
	Control	19.800	3.636	[18.207, 21.393]	0.0899
Participant Interest	*MirrorBot*	19.083	5.453	[16.902, 21.264]	
	Bot-only	15.778	5.309	[13.326, 18.230]	0.0955
	Mirror-only	16.778	4.236	[14.822, 18.734]	0.24
	Control	18.400	4.465	[16.444, 20.356]	0.718
Partner Responsiveness	*MirrorBot*	8.958	2.742	[7.860, 10.056]	
	Bot-only	7.778	2.819	[6.477, 9.079]	0.267
	Mirror-only	7.500	2.792	[6.210, 8.790]	0.172
	Control	8.250	2.693	[7.070, 9.430]	0.49
Shared Reality	*MirrorBot*	3.917	1.613	[3.272, 4.562]	
	Bot-only	3.389	1.501	[2.695, 4.083]	0.406
	Mirror-only	3.333	1.680	[2.557, 4.109]	0.359
	Control	3.550	1.669	[2.819, 4.281]	0.551

Table 3: Descriptive statistics and mixed-effects model p-values for the Human–Human Liking Scale.

Item	Condition	M	SD	95% CI	p
Total Score	*MirrorBot*	17.667	5.954	[15.286, 20.048]	
	Bot-only	16.389	5.031	[14.064, 18.714]	0.546
	Mirror-only	15.833	5.090	[13.481, 18.185]	0.388
	Control	17.400	4.717	[15.332, 19.468]	0.896
I felt that the other participant liked me.	*MirrorBot*	4.375	1.498	[3.775, 4.975]	
	Bot-only	4.056	1.514	[3.356, 4.756]	0.562
	Mirror-only	4.000	1.328	[3.387, 4.613]	0.497
	Control	4.500	1.100	[4.018, 4.982]	0.815
I would enjoy spending more time with the other participant.	*MirrorBot*	4.292	1.756	[3.590, 4.994]	
	Bot-only	4.167	1.295	[3.569, 4.765]	0.83
	Mirror-only	4.111	1.367	[3.480, 4.742]	0.756
	Control	4.350	1.531	[3.680, 5.020]	0.918
I would be happy to talk with this person again in a different setting.	*MirrorBot*	5.083	1.442	[4.507, 5.659]	
	Bot-only	4.667	1.328	[4.054, 5.280]	0.454
	Mirror-only	4.389	1.420	[3.732, 5.046]	0.216
	Control	4.900	1.619	[4.190, 5.610]	0.734
I felt connected to the other participant.	*MirrorBot*	3.917	1.666	[3.251, 4.583]	
	Bot-only	3.500	1.757	[2.689, 4.311]	0.496
	Mirror-only	3.333	1.609	[2.590, 4.076]	0.342
	Control	3.650	1.631	[2.935, 4.365]	0.653

Table 4: Descriptive statistics and mixed-effects model p-values for the Relational Communication Scale (RCS).

Item	Condition	M	SD	95% CI	p
Total Score	*MirrorBot*	24.250	7.859	[21.106, 27.394]	
	Bot-only	22.389	6.608	[19.335, 25.443]	0.516
	Mirror-only	20.611	7.237	[17.267, 23.955]	0.208
	Control	23.600	6.541	[20.733, 26.467]	0.815
Composure	*MirrorBot*	9.000	2.919	[7.832, 10.168]	
	Bot-only	8.611	2.615	[7.404, 9.818]	0.715
	Mirror-only	7.778	2.981	[6.400, 9.156]	0.255
	Control	8.800	2.802	[7.571, 10.029]	0.846
Immediacy / Affection	*MirrorBot*	5.167	1.685	[4.493, 5.841]	
	Bot-only	4.778	1.700	[3.992, 5.564]	0.514
	Mirror-only	4.500	1.689	[3.720, 5.280]	0.266
	Control	5.050	1.276	[4.491, 5.609]	0.84
Receptivity / Trust	*MirrorBot*	5.083	1.932	[4.311, 5.855]	
	Bot-only	4.222	1.801	[3.391, 5.053]	0.282
	Mirror-only	4.111	2.055	[3.162, 5.060]	0.225
	Control	4.850	2.084	[3.937, 5.763]	0.762
Similarity / Depth	*MirrorBot*	5.000	1.888	[4.245, 5.755]	
	Bot-only	4.778	1.309	[4.172, 5.384]	0.716
	Mirror-only	4.222	1.517	[3.520, 4.924]	0.208
	Control	4.900	1.334	[4.316, 5.484]	0.866

Table 5: Descriptive statistics and mixed-effects model p-values for the Inclusion of Other in the Self Scale.

Item	Condition	M	SD	95% CI	p
Distance between self and other	*MirrorBot*	124.848	76.535	[94.227, 155.469]	
	Bot-only	174.291	90.089	[132.672, 215.910]	0.231
	Mirror-only	276.560	154.775	[205.057, 348.063]	0.000646
	Control	188.289	89.518	[149.056, 227.522]	0.116

Table 6: Descriptive statistics and mixed-effects model p-values for Overall Interaction Experience.

Item	Condition	M	SD	95% CI	p
Happy	*MirrorBot*	5.875	3.040	[4.658, 7.092]	
	Bot-only	3.667	2.970	[2.295, 5.039]	0.0702
	Mirror-only	3.222	2.962	[1.854, 4.590]	0.0313
	Control	4.550	3.000	[3.235, 5.865]	0.257
Awkward	*MirrorBot*	3.208	3.323	[1.879, 4.537]	
	Bot-only	4.278	2.585	[3.084, 5.472]	0.288
	Mirror-only	2.111	2.471	[0.970, 3.252]	0.276
	Control	3.350	2.796	[2.125, 4.575]	0.884
Uncomfortable	*MirrorBot*	2.000	2.703	[0.918, 3.082]	
	Bot-only	2.556	2.307	[1.490, 3.622]	0.532
	Mirror-only	1.611	2.547	[0.435, 2.787]	0.661
	Control	1.450	1.761	[0.678, 2.222]	0.524
Enjoyable	*MirrorBot*	5.417	3.049	[4.198, 6.636]	
	Bot-only	3.278	3.102	[1.845, 4.711]	0.0887
	Mirror-only	2.556	2.915	[1.209, 3.903]	0.0249
	Control	3.400	2.891	[2.134, 4.666]	0.0979
Vulnerable	*MirrorBot*	1.667	2.099	[0.828, 2.506]	
	Bot-only	1.389	1.975	[0.476, 2.302]	0.64
	Mirror-only	0.778	1.478	[0.096, 1.46]	0.137
	Control	1.550	1.905	[0.715, 2.385]	0.84

Table 7: Descriptive statistics and mixed-effects model p-values for Initiating a Conversation.

Item	Condition	M	SD	95% CI	p
Awkward	*MirrorBot*	3.292	1.756	[2.590, 3.994]	
	Bot-only	4.278	1.809	[3.443, 5.113]	0.0862
	Mirror-only	3.667	2.000	[2.744, 4.590]	0.511
	Control	4.450	1.731	[3.691, 5.209]	0.0388
Uncomfortable	*MirrorBot*	2.833	1.373	[2.284, 3.382]	
	Bot-only	3.722	1.809	[2.887, 4.557]	0.0901
	Mirror-only	3.444	1.822	[2.603, 4.285]	0.242
	Control	4.300	1.689	[3.559, 5.041]	0.00464
Easy	*MirrorBot*	4.917	1.139	[4.462, 5.372]	
	Bot-only	3.778	1.700	[2.992, 4.564]	0.0245
	Mirror-only	4.389	1.501	[3.695, 5.083]	0.284
	Control	4.450	1.572	[3.760, 5.140]	0.329
Vulnerable	*MirrorBot*	2.625	1.498	[2.025, 3.225]	
	Bot-only	3.222	1.517	[2.520, 3.924]	0.207
	Mirror-only	2.611	1.243	[2.037, 3.185]	0.976
	Control	3.500	1.638	[2.783, 4.217]	0.0604

Table 8: Descriptive statistics and mixed-effects model p-values for Social Presence.

Item	Condition	M	SD	95% CI	p
Total Score	*MirrorBot*	39.333	11.702	[34.651, 44.015]	
	Bot-only	30.833	13.439	[24.624, 37.042]	0.0982
	Mirror-only	30.833	12.435	[25.088, 36.578]	0.0982
	Control	34.550	12.116	[29.240, 39.860]	0.332
Attention Allocation	*MirrorBot*	10.542	3.538	[9.127, 11.957]	
	Bot-only	7.889	4.324	[5.892, 9.886]	0.0802
	Mirror-only	8.778	4.124	[6.873, 10.683]	0.239
	Control	9.950	3.203	[8.547, 11.353]	0.682
Co-presence	*MirrorBot*	11.125	2.328	[10.194, 12.056]	
	Bot-only	9.944	3.096	[8.513, 11.375]	0.22
	Mirror-only	9.889	3.179	[8.421, 11.357]	0.199
	Control	9.800	3.019	[8.477, 11.123]	0.157
Perceived Affective Understanding	*MirrorBot*	8.375	3.160	[7.111, 9.639]	
	Bot-only	6.389	3.616	[4.719, 8.059]	0.15
	Mirror-only	6.000	3.361	[4.448, 7.552]	0.0871
	Control	6.850	3.573	[5.284, 8.416]	0.252
Perceived Message Understanding	*MirrorBot*	9.292	4.016	[7.685, 10.899]	
	Bot-only	6.611	4.075	[4.729, 8.493]	0.13
	Mirror-only	6.167	4.328	[4.168, 8.166]	0.079
	Control	7.950	4.236	[6.094, 9.806]	0.429

E Descriptive and Inferential Statistics of Behavior Measures

Table 9: Descriptive statistics and p-values for pairwise comparisons with the *MirrorBot* condition for the behavioral measures. All measures are proportions of time spent during the entire session, ranging from 0 to 1.

Item	Condition	M	SD	95% CI	p
Shared Attention	*MirrorBot*	0.230	0.111	[0.159, 0.300]	
	Bot-only	0.104	0.098	[0.029, 0.179]	0.013
	Mirror-only	0.021	0.038	[-0.011, 0.053]	0.00003
	Control	0.022	0.064	[-0.024, 0.068]	0.00003
Emotional Revealing	*MirrorBot*	0.088	0.061	[0.049, 0.126]	
	Bot-only	0.051	0.061	[0.005, 0.098]	0.191
	Mirror-only	0.027	0.041	[-0.007, 0.061]	0.016
	Control	0.054	0.065	[0.007, 0.100]	0.225
Mutual Goal	*MirrorBot*	0.020	0.031	[0.000, 0.039]	
	Bot-only	0.008	0.020	[-0.007, 0.023]	0.307
	Mirror-only	0.009	0.025	[-0.012, 0.030]	0.410
	Control	0.005	0.015	[-0.006, 0.015]	0.157
Phone Usage	*MirrorBot*	0.380	0.286	[0.199, 0.562]	
	Bot-only	0.555	0.423	[0.230, 0.880]	0.305
	Mirror-only	0.639	0.420	[0.287, 0.990]	0.156
	Control	0.424	0.500	[0.066, 0.782]	0.811
Self-Disclosure	*MirrorBot*	0.217	0.231	[0.070, 0.364]	
	Bot-only	0.069	0.127	[-0.029, 0.166]	0.078
	Mirror-only	0.104	0.160	[-0.030, 0.238]	0.214
	Control	0.284	0.335	[0.045, 0.524]	0.597
Talk	*MirrorBot*	0.463	0.384	[0.220, 0.707]	
	Bot-only	0.211	0.388	[-0.087, 0.510]	0.157
	Mirror-only	0.307	0.423	[-0.047, 0.660]	0.413
	Control	0.458	0.478	[0.116, 0.800]	0.977

F Behavior Measure Codebook

Table 10: Behavioral Coding Scheme

Code	Definition
Experiment Setting Markers	
Session Start	Timestamp when the last participant sits down and the session formally begins.
Robot In	Start: When the robot enters and becomes visible to both participants. End: When the robot stops and positions itself in front of them.
Robot Leaves	Start: When the robot begins to move away. End: When it fully exits the participants' field of view.
Mirror Move	Duration in which the robot adjusts or rotates its mirror(s), changing visual perspectives.
Session End	When researchers re-enter the room to signal the end of the study session.
Initiation Behavior Markers	
First Talk	First visible interaction between participants, including eye contact, smiling, or verbal greetings.
First Talk After Robot In	First interaction initiated after the participants become aware of the robot (e.g., eye contact, smile, or talking triggered by the robot's presence).
Environmental Effect Markers	
Looking at the Phone	Start–End: One or both participants use a mobile phone (e.g., checking screen, browsing, showing content).
Attention on Robot	Start–End: Participants share attention on the robot, e.g., looking, pointing, or commenting on it together.
Attention on Other Things	Start–End: Participants share attention on objects or events unrelated to the robot (e.g., looking at decor, display, or others in the room).
Mutual Goal	Start–End: Participants engage in a shared or coordinated task (e.g., navigating the space together or jointly manipulating objects).
Interpersonal Behavior Markers	
Talk	Start–End: Any verbal conversation between participants, regardless of topic.
Self-Disclosure	Start–End: Sharing personal information, stories, or showing personal content (e.g., photos) on phones.
Information Seeking	Start–End: Asking questions to learn about the other person (e.g., "Where are you from?") or about the shared environment.
Emotional Revealing	Start–End: Verbal or visible expression of emotional states or feelings (e.g., "I feel dizzy," laughing, sighing).
Synchronized Movement	Start–End: Participants exhibit temporally aligned or mirrored physical movements (e.g., leaning in together, rotating, standing up in sync).
Talk about Robot	Participants explicitly talk about the robot (e.g., its behavior, appearance, or function).
Talk about Other Things	Participants talk about any topic unrelated to the robot (e.g., hobbies, background, environment).

G Correlation between Personality Traits and Outcome Measures

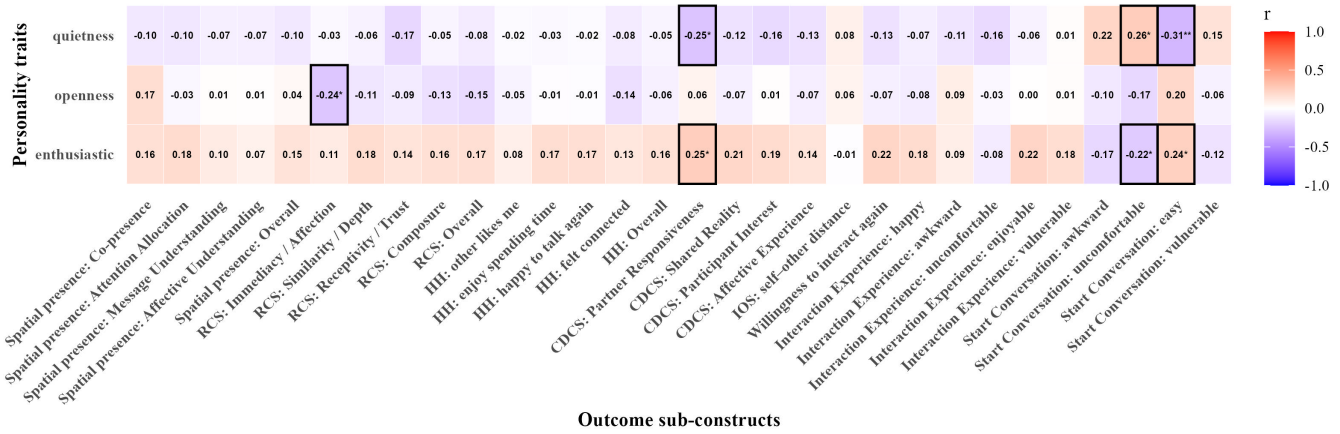


Figure 15: Correlogram illustrating the correlations between personality traits (Openness, Quietness, Enthusiasm) and all outcome measures. The black border represents significance.