

Enacting Future Protocols for Spontaneous Crossing between Mixed Realities

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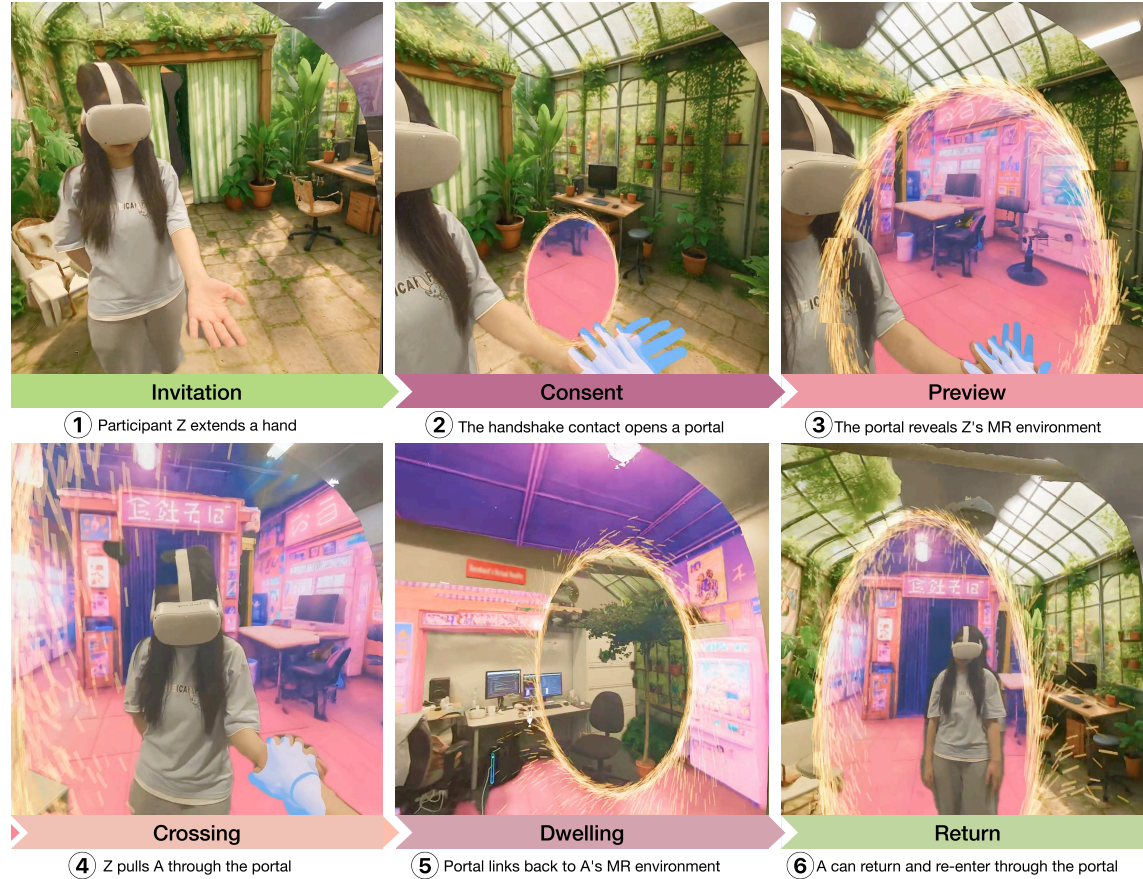


Fig. 1. The TouchPort handshake sharing flow, shown from participant A's perspective. A handshake initiates consent and opens a portal into the participant Z's MR environment; A crosses, dwells, and can return through the portal independently.

Mixed-reality glasses may become ubiquitous in the near future. But they will not necessarily create shared realities: headsets are private by default. Mixed reality (MR) systems increasingly support co-located shared content, yet offer few socially legible ways to enter another person's MR. We examine spontaneous mixed-reality crossing: ad hoc encounters in which one person opens a personal MR layer to another. We ask why people cross, how crossing unfolds, and what a crossing protocol enables. Through research through design, we present two protocol designs as immersive speculative enactments ($n=25$) that make this future encounter experienceable. MenuPort manages invitation and entry through menu-based requests and responses, while TouchPort re-protocolizes an embodied handshake-and-pull gesture that opens a portal, combining invitation, consent, and crossing into a single action. We contribute (1) a framing of crossing mixed realities; (2) protocol artifacts; (3) empirical reflections; and (4) a protocol design space.

CCS Concepts: • **Human-centered computing** → **Mixed / augmented reality**; *Empirical studies in HCI*.

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1 Introduction

Mixed reality (MR) glasses are moving out of demonstrations and into everyday work and leisure, worn in the presence of other people [100, 132]. HCI increasingly treats this ubiquity as a near-term condition to design for rather than a distant prospect [35, 67]. But the ubiquity of mixed-reality wearables does not guarantee a shared reality. Each wearer is served a personalized environment [129], variously described as an *actuality* [7] or a mixed-reality *layer*, so people in one room can be looking at entirely different content [101]. Mixed-reality content in headsets is private and siloed by default.

Imagine meeting a colleague who is arranging mixed reality objects around their desk. You can see the colleague and the desk, but your headset does not display the objects in their personal mixed reality. When they ask you to look at their work, a familiar invitation encounters an unfamiliar interaction problem. How would you enter the mixed reality they are already inhabiting, understand what they are offering to share, and return to your own?

We investigate this possibility as *spontaneous mixed-reality crossing*: a co-located transition from independently inhabited actualities toward a temporary shared experience, in an encounter that has not been organized around a shared digital session. Such moments will occur in ordinary settings. Nearby sharing such as AirDrop offers a familiar analogy for a need that arises in the moment. In MR, however, the invitation may concern a spatial experience and an ongoing activity as well as a transferable object.

Co-located mixed reality and transitions between environments have substantial histories in HCI. Early collaborative AR supported shared objects, independent views, and face-to-face work [13, 15, 131], and recent cross-reality systems support viewing another person’s environment, moving objects between realities, and co-located passage [24, 107, 137]. Most of this work is not spontaneous; the association is established before the encounter begins. Partners are recruited and equipped together, the pairing is configured in advance, and each person already knows there is another reality to enter.

Within this history, spontaneous crossing between mixed realities remains underexplored as an interpersonal practice. Existing transition techniques establish ways to move or share; they leave open why a particular crossing would be worthwhile, how its participants would experience the invitation and passage, and what they would want to do together. These questions matter when the purpose and participation arrangements of a shared session have yet to be established. Difference between two views does not itself create a reason to cross. A crossing might be unnecessary, interrupt an activity, reveal unwanted content, or impose an uncomfortable interaction. Understanding these objections is part of understanding whether this future should become an everyday practice.

We approach this near-future scenario through *immersive speculative enactments* (ISEs), which use interactive immersive environments to place participants inside a future arrangement they can act within and interpret [124]. An enacted crossing gives participants a common experiential reference: they encounter another person, respond to an invitation, experience a transition, and consider how to end it. Their explanations, hesitations, and alternatives then give substance to questions about a practice that is not yet established.

Two protocols make contrasting arrangements available for this inquiry. *MenuPort* adapts the SharePlay workflow to Meta Quest through interface-based selection, requests, and responses. *TouchPort* organizes crossing through a reciprocal handshake and a portal, drawing on a familiar bodily convention to combine invitation, response, and opening. The protocols differ in the complete experience they organize, including the transition, movement, object

transfer, and exit. An artistic extension, *Allow Me into Your Dream*, develops TouchPort into a setting for visiting, gifting, and changes to personal environments. Together, the two protocols and the artwork make both the process of crossing and its further possibilities available for experience and discussion.

Three questions guide the inquiry:

- **RQ1:** Why and under what circumstances would people want to cross between their personal mixed realities?
- **RQ2:** How do participants experience invitation, entry, and exit through embodied and interface-based crossing protocols, and what benefits and drawbacks do they identify?
- **RQ3:** What future encounters and activities do participants imagine these crossing protocols could enable?

A formative designer workshop informed the design development. Study A compares MenuPort and TouchPort through individual questionnaires and interviews with twelve participants; Study B examines exhibition encounters with the artistic extension through interviews with thirteen participants. Across these materials, participants valued purposeful visits and interpersonal connection, while questioning unwanted access, touch, and socially demanding exits. They proposed further activities and ways to recombine the protocols. A particularly consequential distinction is between combining actions and combining decisions: a joint opening can be meaningful even when the people involved want separate choices about entering, disclosing, and leaving.

This paper contributes:

- (1) A framing of crossing mixed realities as a problem of socially legible admission rather than file transfer.
- (2) Two enacted crossing protocols, MenuPort and TouchPort, and an artistic extension that make spontaneous crossing available for comparative experience and speculative inquiry. The handshake-based artifact has previously been presented as an immersive experience [4]; the present paper develops the empirical inquiry conducted through it.
- (3) Empirical accounts of why participants would cross, how they experienced the protocols' benefits and drawbacks, and what further encounters and activities they imagined.
- (4) A generative design space connecting purposes and non-participation, the organization of participation decisions, and subsequent activities and social practices. The space develops from the choices, tensions, and recombinations made discussable through enactment.

2 Background and Related Work

2.1 Sharing and Crossing Between Co-located Realities

Connecting co-located realities has a substantial history in HCI. Early collaborative AR supported face-to-face work around shared objects while allowing independent viewpoints and differentiated information layers [13, 15, 18, 43, 110, 119, 120, 131], and mixed-reality boundaries connected heterogeneous displays with physical and synthetic spaces [11]. Surveys subsequently organized collaborative MR through awareness, communication, coordination, spatial distribution, and the symmetry of participants' roles and equipment [28, 37, 123]. These precedents establish both sharing and difference between participants' views as design concerns: physically sharing a setting has never required identical digital experiences.

Transitional and traversable interfaces address movement between those experiences [14, 47, 72, 77], and cross-reality taxonomies situate such transitions alongside asymmetric participation across the reality–virtuality continuum [8, 42, 66]. Asymmetric collaboration research examines differentiated viewpoints and awareness cues among headset, desktop, and non-headset participants [39, 46, 56, 97, 102], while co-located systems connect wearers, non-users, and

spectators [31, 53, 107, 137]. Transition research examines continuity, bidirectionality, object transfer, and control across contexts [24, 45, 104, 121, 122, 135], supported by dedicated prototyping environments [50]. This body of work supplies the techniques for representing a boundary, a destination, and movement across it.

Much of it, however, begins from prepared encounters: collaborators are recruited and equipped, environments are configured, and the existence of another reality is established before interaction starts [24, 45, 102, 104, 122]. Our inquiry asks what gives a passage purpose when none of that preparation has happened.

Everyday wearable AR makes the unprepared condition ordinary, with people occupying one physical place while inhabiting different mediated actualities [7, 40, 49, 52, 87]. Personalization, fragmentation, and platform boundaries are examined as consequences for shared worlds and authority [20, 60, 96, 101, 129, 133]. A common physical setting therefore no longer guarantees a common perceptual public, which is what gives crossing something to cross.

Spontaneity is itself an established MR concern. Co-located bodily play, street play, and in-the-wild XR examine encounters that were not arranged in advance [62, 63, 100, 128, 132], while work on intent inclusivity recognizes that people may wish to participate, observe, or avoid an interaction [61]. We focus on spontaneous crossing as a particular problem within this broader agenda: moving from independently inhabited personal realities toward a temporary shared experience in an encounter that was not organized around a shared digital session. The open questions concern when a visit is worthwhile, how participants experience its negotiation and passage, and what they imagine doing together.

2.2 Privacy and Consent Across a Spontaneous Encounter

Ubiquitous computing established substantial resources for temporary connections. Interest-signaling badges, profile exchange, local awareness, and serendipitous social computing explored encounters without a prearranged collaboration [16, 34, 58, 78, 109], and situated-information systems connected environmental identifiers to portable interfaces [76, 113, 114]. Device association made nearby connection actionable through pick-and-drop, shaking or bumping devices together, and synchronized input [57, 59, 111, 112], while authentication research and cross-device taxonomies distinguish endpoint selection, physical action, communication channel, and trust [9, 17, 22, 41, 70].

These histories also separate what a connection means socially. Public surfaces and phone sharing distinguish awareness, showing, handing over, session participation, and keeping a copy [65, 71, 84, 88], and proxemic critique cautions against treating approach or inferred attention as authorization [48]. MR pairing, shared anchors, and registration supply further components for establishing endpoints and spatial agreement [26, 64, 89, 93, 126, 127]. Everyday nearby-sharing infrastructure combines discovery, identity checks, transport, and receiving controls in one arrangement [5, 6], which research on private discovery, wireless attack surfaces, and unsolicited delivery examines part by part [55, 83, 130, 141]. Crossing a personal reality raises a further question that none of these settle: what participation does that connection authorize?

Privacy research shows why connection alone cannot answer it. Ubiquitous sensing weakens the feedback and control through which people regulate information about themselves, and makes informed consent difficult when sensing and interpretation are hard to perceive [10, 85]. Security and privacy work on AR separates sensing, application access, and rendered output, and investigates ownership, selective disclosure, and permissions over shared objects [29, 81, 108, 117, 118]. Bystander studies examine recording awareness, privacy mediation, sensitive contexts, and consent concerning information about others [1, 12, 30, 74, 75, 98, 116], while social-acceptability and dyadic-interaction research shows why a wearer's preferences cannot stand in for those of the person opposite them [2, 3, 23, 82, 90, 94, 115]. Applied to a

spontaneous encounter, these concerns draw attention to what people can understand before agreeing and what they can change as the interaction unfolds.

Control over shared content and the social organization of entry and exit are addressed as well. Output management, access control, normative tension, and shared-state security enforce particular arrangements [79, 80, 105, 125], and studies of host and guest roles in shared VR include how a guest obtains permission to arrive and to depart [38, 138]. Together these works place both the terms of access and the choreography of entry and exit within the design problem.

Most directly, Windl et al. [139] develop consent mechanisms for spontaneous AR interactions through focus groups and expert co-design, addressing consent to the processing of private information across different spontaneous scenarios. We build on this concern while following an interpersonal crossing between spatial environments, including the reason to visit, the experience of passage, and activities made possible by the connection. The tension is how to fit participation decisions into the pace of an encounter: separate controls can clarify decisions but demand attention, while combined actions can support coordination but leave distinct commitments ambiguous. MenuPort and TouchPort make contrasting arrangements of this tension available for experience and discussion.

2.3 Embodied Interaction and Social Rituals

A handshake brings a learned social practice into the protocol. Corfield [27] traces its spread in Britain between 1700 and 1850 through mercantile, religious, and wider social networks, showing how egalitarian meanings developed within particular social settings. The account also identifies differences related to social position and gender. This history motivates treating the handshake’s meaning as situated; recognizability alone cannot establish that it is welcome or communicates agreement to a particular digital consequence.

Embodied interaction offers a basis for examining the relation between an action and its setting. Dourish [32] connects tangible and social interaction through situated practice. Cooperative gestures demonstrate how several people’s actions can contribute to a combined system command [95], and iBand used handshakes to exchange social information while already identifying control over personal information as a design concern [68]. Street play and public XR further show how bodily conduct can make otherwise inaccessible digital activity legible to the people nearby [62, 69, 99, 106]. TouchPort extends this relationship between bodily coordination, social meaning, and information exchange to opening a spatial passage into another person’s MR environment.

Ritual design further concerns how actions and objects mark changes in relationships or participation. Mah et al. [86] translate aspects of Buddhist ritual into an interactive artwork through meaningful bodily action, focused attention, and a designed conclusion. Klüber et al. [73] investigate artifacts for relationship transitions, while Uriu et al. [134] connect floral tributes with virtual commemoration. These studies make the surrounding practice and participants’ interpretations central to the meaning of an interaction. They inform our examination of offering a hand, responding, crossing together, and closing a visit. Whether those actions convey welcome, create obligation, or invite alternative gestures remains a question for the enactments. Personalized gestures and souvenirs also suggest possible practices whose development would require repeated encounters to study.

2.4 Enacting Possible MR Futures

Speculative design and Research through Design play complementary roles in this inquiry. Dunne and Raby [33] use designed propositions to open discussion about alternative ways of living with technology. Zimmerman et al. [142] articulate how design practice can contribute research knowledge through the development of artifacts. Futuring work on everyday AR has since used scenarios, dark scenarios, and expert elicitation to examine what ubiquitous



Fig. 2. The MenuPort UI-menu sharing flow. (1) A opens the menu and selects Z; (2) A sends the sharing request; (3) Z receives the request; (4) Z accepts; (5) Z joins A's MR environment. Each step shows both participants' perspectives.

augmentation would mean in public life [35, 51, 67, 103]. Here, speculative design directs attention toward futures people might welcome, question, or resist; RtD grounds the inquiry in making, revising, and reflecting on the protocols through which those futures are presented.

Speculative enactment provides a way to involve participants in these propositions. Elsdon et al. [36] place participants in imagined arrangements that have consequences for their present actions and experiences, foregrounding their social and emotional stakes, and design-fiction work shows how such materials surface disagreement rather than consensus [21]. Immersive speculative enactments extend this approach through interactive virtual environments [124], and Cools et al. [25] apply the approach to future MR contact lenses to explore implications for everyday life. Our design space is assembled from these enacted examples in the manner described by Halskov et al. [54], who derive a space from a collection of designs rather than from an a priori taxonomy. These precedents inform our use of an executable encounter as a shared reference for participants' explanations, objections, and alternatives.

3 Protocol Design

3.1 Design Premise and Shared Protocol Sequence

The project began with the possibility of *co-located isolation*: people sharing a physical room while each inhabits a personal mixed reality the others cannot see. Moving out of that condition requires a protocol, and we organize the

functions such a protocol must address as a sequence of seven: *Discover* → *Invite and Consent* → *Confirm* → *Allow* → *Spatial Colocation* → *Sync Objects* → *Permission Management*.

Discover concerns finding and identifying a potential partner among the people present. *Invite and Consent* concerns expressing an offer and responding to it, which is where each person decides whether to take part. *Confirm* concerns understanding the destination and what is being offered. *Allow* makes the response operative by opening access. *Spatial Colocation* establishes the common spatial reference a shared experience needs. *Sync Objects* maintains the relevant shared content and state. *Permission Management* concerns the continuation, adjustment, and termination of access after entry.

These functions describe relationships rather than successive user actions, and the two designs distribute them differently. Table 1 sets them side by side, separating what each design exposed to participants from what the implementation supplied in the background: devices and spatial alignment were configured for the encounter, synchronization continued during sharing, and ending access was handled differently by each protocol.

We developed two contrasting propositions against this sequence. *MenuPort* keeps the functions separate and reaches each one through an interface, following the path a near-future platform would most plausibly take. *TouchPort* performs them with the body, so that several functions coincide in a single act. The two make different arrangements of the same functions available for participants to experience and compare (Figure 3).

3.2 MenuPort: Crossing Through Menus

MenuPort is an interface-based crossing protocol for co-located MR (Figure 2). It adapts the request-and-response organization of SharePlay’s nearby sharing workflow [6] to a prototype on Quest, offering the interface path a person would expect for identifying another person, sending an invitation, responding to it, and ending the resulting connection. The adaptation concerns this interaction flow; networking and environment transitions are implemented within the Quest application.

The path a participant walked was stepwise, with each function reached through a separate interface action. For *Discover*, the initiator opened a wrist menu by touching the right wrist with the left index finger and selected a nearby participant. For *Invite and Consent*, the initiator sent a sharing request, which the recipient could accept or cancel. *Confirm* had no step of its own: the request preceded a direct environment switch and offered no preview of the destination. For *Allow*, acceptance switched the recipient’s visible MR environment to the initiator’s while the initiator’s view remained unchanged, establishing a directional visit into the initiator’s layer. For *Permission Management*, either participant could reopen the menu and select *stop sharing*, after which both returned to their initial MR layers. *Spatial Colocation* and *Sync Objects* operated in the background: the shared spatial reference was configured for the study, and this version carried shared environment state without cross-layer object transfer.

Four deliberate interface actions across two people therefore preceded any opening. The transition occurred without a portal or a walk through a threshold, and the effect of acceptance was visible only through the change of environment.

3.3 TouchPort: Crossing Through Handshakes and Pulls

TouchPort is an embodied crossing protocol built on the handshake. It re-protocolizes a greeting convention already used to open an encounter between two people [27], so that the action through which two people acknowledge one another is also the action that opens a passage between their environments. The invitation becomes something people perform toward one another rather than something an interface delivers on their behalf.

Table 1. MenuPort and TouchPort compared across the shared crossing functions of Section 3.1. Functions can be combined, preconfigured, or continuous; rows do not imply seven successive user actions.

Function	MenuPort	TouchPort
Discover	Select a nearby participant from the wrist menu.	Direct a hand toward the intended partner.
Invite and Consent	Send a request; recipient accepts or cancels.	Offer, reciprocate, and sustain a handshake.
Confirm	Request precedes a direct environment switch; no spatial preview.	Open portal permits looking before walking through; no separate permission summary.
Allow	Acceptance switches the recipient into the initiator's layer.	Two-second handshake opens a connection between layers.
Spatial Colocation	Shared spatial reference configured for the study.	Shared spatial reference configured for the study.
Sync Objects	Shared environment state; no cross-layer object transfer.	Networked state and object transfer through the portal; no room mutation in Study A.
Permission Management	Either person can stop sharing through the menu.	Another joint two-second handshake closes sharing.

The protocol compresses the opening functions into one continuous action. Offering a hand toward a particular person performs *Discover* and opens *Invite and Consent* in the same movement: the direction of the hand identifies the intended partner without a list or a selection step, and the offer it makes is already the invitation. Reciprocating completes *Invite and Consent*, directing a response back to that person, and sustaining the handshake performs *Allow*, opening a portal between the two environments (Figure 1). *Confirm* then follows the opening rather than preceding it: the portal presents the destination and a route through it, so a visitor can look before walking across, and a gentle guiding pull carries them over (Figure 1). The design draws on the social recognizability of offering and taking a hand, while leaving the meaning and acceptability of that action open to participants' interpretations.

In the comparison version, holding a handshake for two seconds triggered the portal. The connected environments remained spatially distinguishable, with the portal providing a visible relation between the destination and the environment left behind, and the continued opening allowed movement back through the boundary (Figure 1e–f). *Spatial Colocation* was configured for the study, as in MenuPort.

For *Sync Objects*, participants could pinch and move virtual objects, including flowers, and pass an object through the portal into the other layer; in this version, transfer did not activate the artwork's room-transformation rules. For *Permission Management*, the participants held another two-second handshake to close the portal, making the ending as reciprocal as the beginning. Walking back into one's initial environment and terminating sharing were therefore different actions: physical return alone did not perform the joint closure this version required. The bodily action communicates and coordinates the encounter; it does not itself transmit digital content.

Putting consent in a reciprocal bodily action also changes what being discoverable is. In wireless nearby sharing, a device advertises to whoever is in range, so unwanted contact can arrive without its owner having done anything, which is the condition that unsolicited-delivery research describes [83]. Under TouchPort there is nothing to address until someone extends a hand: the act that makes a person discoverable is the same act that expresses willingness to be found, and it can only be performed by someone co-present and reciprocated by someone facing them. Agreement is therefore perceptible to both people at the moment it is given, rather than inferred from a selection in a list of nearby devices. Device-association research pursues the same coupling when it uses a shared physical action to establish which endpoints are connecting [9, 57, 59]. The claim is not that this resists attack. Nearby-sharing handshakes have themselves

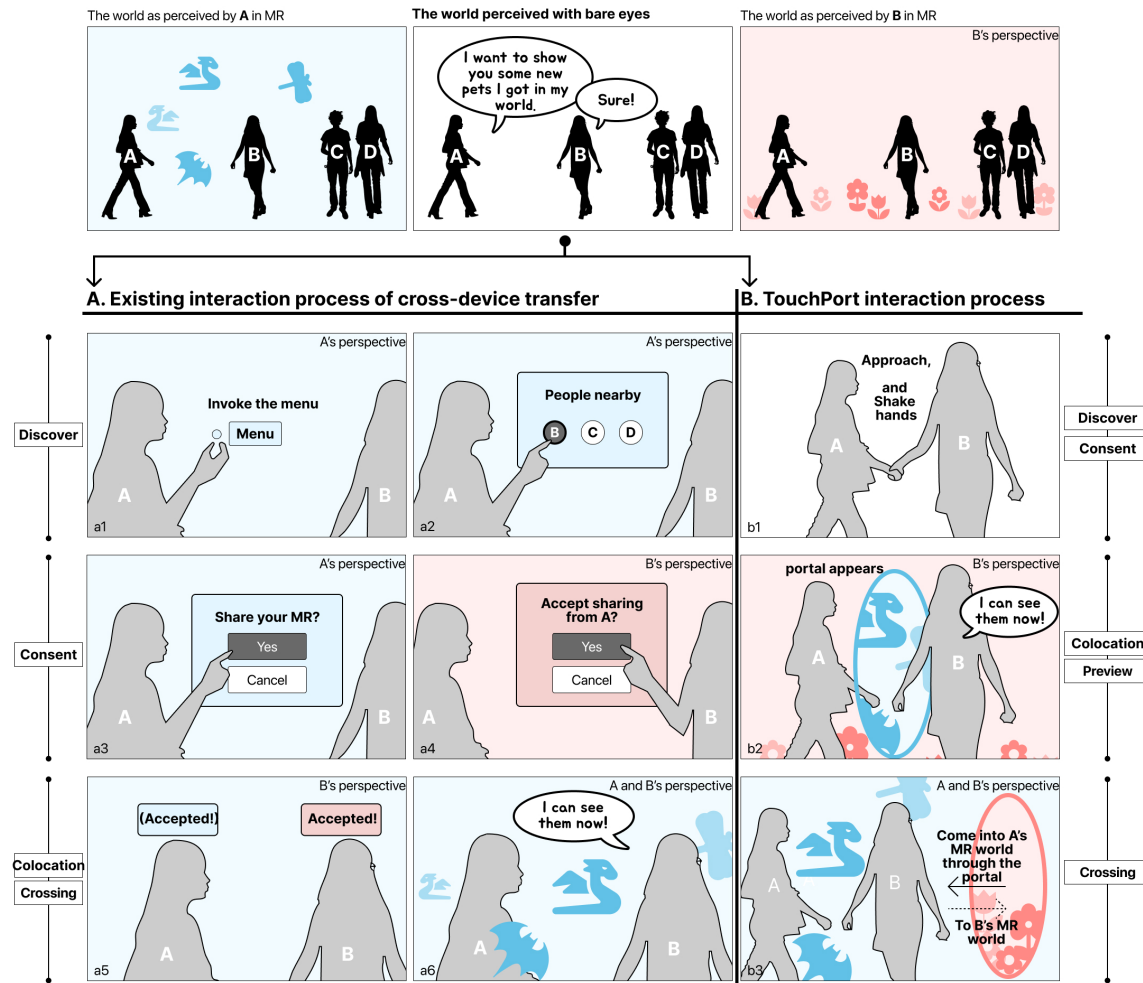


Fig. 3. The interaction process of mixed-reality sharing compared across the two methods. A. MenuPort uses UI interfaces in MR, following existing cross-device transfer protocols. B. TouchPort uses a handshake to open a portal into the other reality. Labels down the outer edges mark which crossing functions each step carries.

been shown attackable from nearby devices [55, 130], and we did not evaluate TouchPort against an adversary. The claim is that discovery, invitation, and consent become one witnessed act rather than three separable system states.

3.4 Allow Me into Your Dream: Multi-User Experiences based on TouchPort

Allow Me into Your Dream asks what people could do once TouchPort makes crossing available. The artwork places participants in different stylized MR rooms over the same physical setting, including a playroom, a phone booth, and a cloud room. A handshake opens a portal through which visitors can look, enter, and exchange objects. The title presents the encounter as being allowed into someone else's dream, giving the crossing an interpersonal and imaginative context.

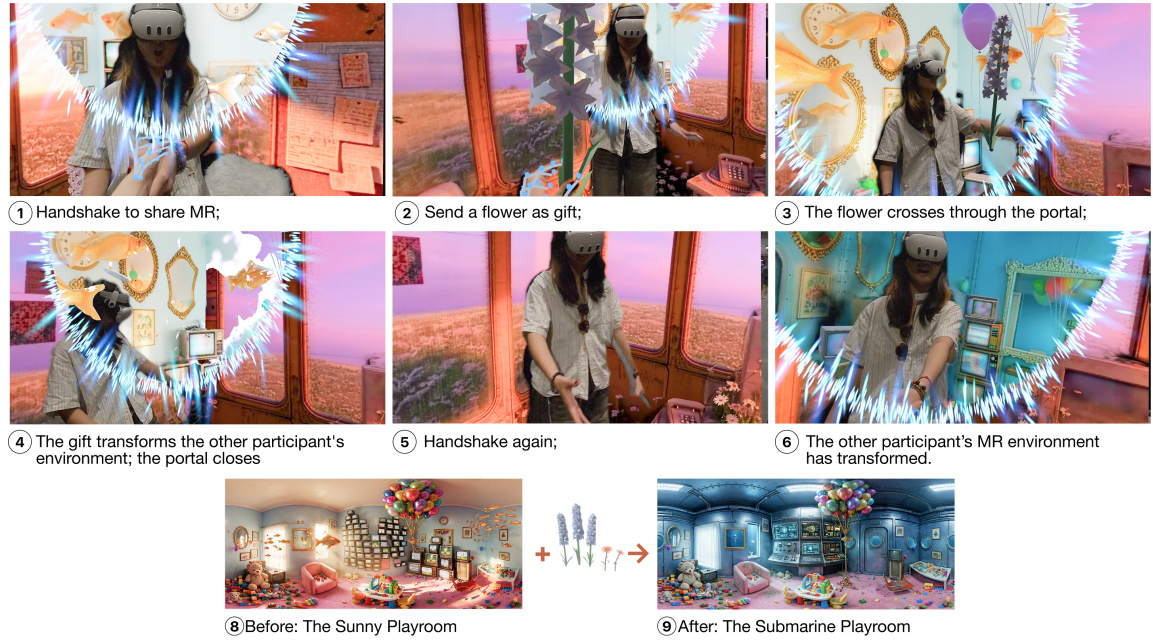


Fig. 4. First-person captures from *Allow Me into Your Dream*. Participants share MR through a handshake (1), send virtual gifts through the portal (2–3), and the gift transforms the recipient’s environment (4–6). Panels 8–9 show the environment before and after receiving a gift. The artwork extends TouchPort with gift-giving and environment mutation; Study A’s protocol comparison uses only the sharing mechanism and does not include the gift-sending flow.

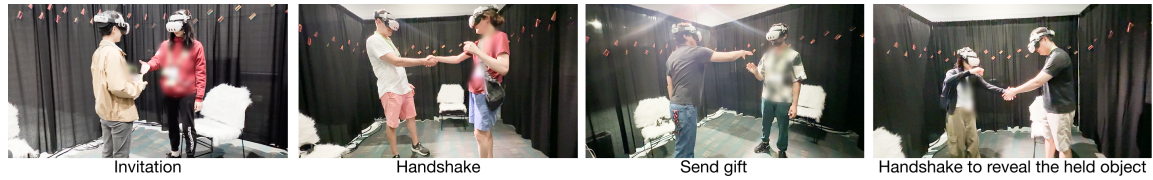


Fig. 5. Third-person view of the interactions that emerged in *Allow Me into Your Dream*, without MR overlays.

Gift-giving extends the visit beyond viewing another scene. Objects passed through a portal become available in the receiving room and can trigger a local environmental variation. We call the rule set connecting gifts and room changes the *Gift Mutation Grammar*. Rooms and objects have descriptive keywords; their combination selects a variation that retains features of the original room while introducing a change associated with the gift. The resulting scene makes one person’s action consequential for the environment another person inhabits (Figure 5). Examples and the transformation diagram appear in Appendix A.

This design gives participants concrete material for considering influence, exchange, and what an encounter might leave behind. An object transfer, the resulting room variation, and a lasting keepsake are distinct outcomes. The research examines participants’ interpretations and proposed extensions of the experience; persistence across visits depends on the artwork’s particular room and reset behavior. The comparison version of TouchPort retains portal-based transfer but omits room mutation, keeping the artwork’s expanded activity separate from the two protocol conditions.

3.5 Implementation

The prototypes run on Meta Quest 3 headsets in passthrough MR with Meta Colocation [91], implemented in Unity with networked multiplayer support. Shared Spatial Anchors [92] align both headsets to a single spatial reference in the same room, so each participant's environment is registered to the same physical space. Hand tracking detects the handshake interaction, and stencil-buffer rendering presents the other environment through the portal. Custom-styled environments were generated from the laboratory setting using World Labs' Marble model [140]. These components support the staged encounter within the application; device discovery, pairing, and alignment were prepared as part of the research setup.

4 Method

4.1 Enactment Setup and Research Logic

Spontaneous crossing in mixed reality is difficult to study as a current practice. Most mixed-reality users have no experience of crossing into another person's reality, and ubiquitous mixed reality, in which it enters everyday life, has not arrived. Since nobody has yet developed the habit of entering another mixed reality, or a settled need to do so, the practice has to be staged speculatively before it can be examined. Asking people to comment on the prospect in the abstract would collect opinions about a technology rather than accounts of an encounter. What is staged therefore has to be a proposition open to rejection rather than a forecast [33], which is what distinguishes a plausible future worth staging from the merely possible [136]. Experiential futures add the further requirement that such a future be encountered rather than described: a scenario someone can inhabit and act within produces reactions that no account of it can elicit [19]. Research through design supplies the complementary commitment, treating the prototype not as a demonstration of a settled design but as the instrument through which the question is asked [142]. These two commitments shape the rest of this section.

Immersive Speculative Enactment (ISE) [124] meets both commitments in one arrangement. It is a particular form of experiential future, in which the staged scenario is inhabited in immersive MR rather than described, and it proceeds as a research-through-design process [142], in which making, reflection, deployment, and empirical response together develop design knowledge [44] about spontaneous MR crossing. Rather than asking people only to imagine a future MR platform, we staged embodied situations in which touching another person, opening a portal, crossing a threshold, moving an object, or ending sharing could become material for reflection. Each version of the artifact functioned as a design proposition in the sense used in speculative design [33] rather than a fixed implementation of a prior theory: it made assumptions about layers, invitation, embodiment, access, and residue available to be experienced and challenged. Design and study therefore developed together, with prototypes clarifying the research questions and participant encounters clarifying what the next prototype needed to make arguable. Before people can evaluate rules for entering another person's MR layer, they need ways to encounter what entering, hesitating, refusing, giving, or leaving might feel like. Table 2 summarizes the three materials, their participants, and the role each plays in the inquiry.

4.2 Formative Designer Workshop

Four XR researchers and designers participated: two project researchers, a facilitator experienced in first-person embodied design, and a doctoral researcher from the same laboratory. A hands-on prototype session and guided body scan preceded narration of imagined MR encounters and collective reflection. Participants discussed experiential qualities, public and private layers, object transfer, and possible traces of encounters. Their accounts informed design

Table 2. Materials and their roles in the inquiry. Identifiers retain their source across the thematic presentation.

Material	Participants	Encounter and records	Analytic role
Formative workshop (PW)	Four XR researchers/designers, including two project researchers	Hands-on exploration, body scan, and collective reflection	Situated design inquiry and development of the propositions
Study A (PC)	Twelve participants	Within-subjects protocol comparison; questionnaires and interviews	Descriptive comparison and explanations of purposes, experiences, and alternatives
Study B (PE)	Thirteen interview participants	Paired artwork experiences; joint, individual, and some follow-up interviews	Interpretation of the artistic encounter and imagined further activities

development as situated first-person inquiry, with their involvement in the project retained in the interpretation of PW material.

4.3 Study A: Comparing MenuPort and TouchPort

Study A took place in a university laboratory. Twelve participants, nine women and three men, were recruited through campus mailing lists and compensated at 15 USD per hour. All were graduate students and HCI researchers. They experienced both protocols in counterbalanced order using the same MR assets.

The TouchPort condition used a two-second handshake to open a portal. Participants could walk between layers, pinch and move objects, and pass them through the portal. Object transfer did not mutate the receiving environment. Another two-second handshake ended the connection. In MenuPort, participants used the wrist menu to select a person and send a request; acceptance switched the recipient into the initiator's layer. Either participant could stop sharing through the menu. MenuPort therefore changed the recipient's environment directly, while TouchPort retained a visible boundary, supported spatial passage and object transfer, and required joint closure. The conditions compare complete protocol configurations rather than a separately manipulated effect of touch.

Participants completed Likert-style measures after each condition and took part in a semi-structured interview lasting approximately 20–30 minutes. The questionnaires included experience and social-context ratings, closeness measures, and comparative choices. Interviews elicited explanations of the two experiences and their suitability for different relationships and situations. The comparison made alternative arrangements available for discussion, including a UI-triggered portal, although that combination was not a third study condition.

4.4 Study B: Experiencing the Artistic Extension

Study B was conducted during exhibitions of *Allow Me into Your Dream*, including an international conference and local pop-up events. Recruitment used email invitations and approaches at exhibition sites. Participants who agreed completed a consent form, experienced the work in pairs, and took part in semi-structured interviews. Both members of some pairs were interviewed together; in other cases only one member agreed. Some participants joined longer follow-up interviews. Interviews lasted 5–40 minutes and were audio-recorded and transcribed.

The interview dataset comprises thirteen participants, six men and seven women. Their backgrounds included MR/VR expertise, development, design, and HCI research; most had graduate-level education or above. Interviews addressed how participants understood sharing, what personal layers or experiences they would share, with whom and

in which situations, and how they would initiate, refuse, or end an encounter. The artwork also provided a setting for accounts of visiting, bodily interaction, and possibilities beyond the prototype.

4.5 Participant Information

Table 3 lists the formative workshop participants, and Table 4 the participants of the two studies. Both studies ran in pairs, since crossing requires a partner.

Table 3. Workshop participants.

ID	Role	Gender
PW01	Author	M
PW02	Workshop facilitator	F
PW03	Attendee	M
PW04	Author	F

Table 4. Participants of Study A and Study B. Each pair experienced the system together. † = partner participated but did not take part in the interview.

Study A				Study B			
ID	Occupation	Gender	Pair	ID	Occupation	Gender	Pair
PC01	Master's student in HCI	M	1	PE01	PhD in HCI, lecturer	M	1 [†]
PC02	Master's student in HCI	F	1	PE02	Master's student in HCI, VR/MR	M	2 [†]
PC03	Master's student in HCI	F	2	PE03	Master's student in HCI	F	3
PC04	PhD student in HCI, VR/MR	F	2	PE04	Master's student in HCI, VR/MR	M	3
PC05	Master's student in HCI	F	3	PE05	PhD student in HCI, VR/MR, lecturer	M	4 [†]
PC06	Master's student in HCI	M	3	PE06	Master's student in HCI	F	5
PC07	PhD student in HCI	F	4	PE07	Industry expert in VR/MR	M	5
PC08	Master's student in HCI	F	4	PE08	Software engineer	M	6
PC09	PhD student in HCI	M	5	PE09	Designer	F	6
PC10	PhD student in HCI	F	5	PE10	Master's student in HCI	F	7
PC11	Master's student in HCI	F	6	PE11	Master's student in HCI	F	7
PC12	PhD student in HCI, VR/MR	F	6	PE12	PhD student in HCI, VR/MR	F	8
				PE13	Undergraduate in HCI	F	8

4.6 Analysis and Evidence Attribution

The analysis combined qualitative coding, design reflection, and descriptive questionnaire summaries. Interview material was organized and coded in MAXQDA. The first author reviewed the data, developed summary themes, and coded the interviews. The second author cross-checked the themes and independently recoded a subset. The authors discussed discrepancies, refined the coding, and consolidated the themes. Study A's questionnaire responses were analyzed and visualized in JMP; the reported comparisons are descriptive, without inferential tests.

Only participants who experienced both conditions contribute direct comparative evidence. Exhibition accounts inform interpretations of the artwork and its TouchPort interaction, while workshop accounts articulate design possibilities from the researchers' situated perspective. We distinguish descriptions of enacted experience from retrospective explanations, imagined alternatives, and informal observations.

4.7 Ethics, Positionality, and Scope

All research activities were reviewed and approved by the local university ethics board. Participants consented to the research as described above. The workshop included project researchers and laboratory colleagues, whose prior involvement shaped the design discussion. Exhibition visitors chose to encounter an artwork, and comparison participants accepted a study involving an embodied interaction. These recruitment settings and the participants' professional backgrounds shape the perspectives represented in the findings.

5 Findings

Participants approached crossing through the person, experience, and occasion involved. They valued being able to encounter something another person saw, and sometimes experienced the transition itself as an act of connection. They also questioned whether a visit was worthwhile, whether its invitation was comfortable to answer, and how they could leave. We organize these accounts around why participants would cross between personal mixed realities, how they experienced the two crossing protocols, and what further activities and encounters they imagined.

Participant identifiers distinguish the sources: PC01–PC12 refer to Study A, the controlled comparison; PE01–PE13 refer to Study B, the exhibition interviews; and PW refers to the formative designer workshop. We cite paired identifiers when the interview did not distinguish the speaker. Questionnaire results describe the twelve controlled-comparison participants; no inferential tests were conducted. Workshop accounts are situated design explorations, and proposed future uses are distinguished from experiences of the prototype. PW01 and PW04 are authors of this paper, so their workshop contributions are reported as situated design reflection rather than as independent participant evidence. In describing the comparison, “handshake” refers to TouchPort, the Handshake-and-Pull Protocol, and “UI menu” to MenuPort, the Virtual Interface Protocol. These packages differed in input, transition, movement, and control, so their comparison does not isolate the effect of physical contact.

5.1 RQ1: Why Cross? Reasons for Sharing Mixed Reality

Participants saw a purpose for crossing when another person could participate in an experience that was difficult to convey from outside. Their examples included exploring a personally meaningful environment, discussing spatial work, and doing something together. However, having different views did not by itself make a visit desirable. The accounts below explain both what participants wanted shared MR to offer and why they might have no reason to share.

5.1.1 Why Sharing Co-located MR. Participants valued co-located MR because it could let another person encounter a view directly while both people remained present and equipped. This differed from description, videos, VR telepresence, or passing over a headset.

Immersive participation. Casting could show content, but participants wanted visitors to explore its spatial qualities. PC05 described sharing “*the whole feeling of a scene*” as the basis for “*a truly immersive discussion*,” rather than a brief reaction to an image.

Being physically present together. Participants also distinguished co-located sharing from remote connection. PC12 described its appeal as “*like online gaming but feeling the real person right beside you*,” while PC01 expected a more embodied experience than “*buttons and clicks on 2D screens*.” The value lay in combining a shared digital scene with the other person’s bodily presence in the room.

Experiencing another view while retaining one's own device. Participants described a gap between hearing about an environment and entering it. PE11 had listened to her partner describe a scene but only understood its strangeness after entering: “*What do you mean there’s fishes above your head?*” PC05 similarly valued encountering something they “*could not imagine*” independently. PE12, an MR developer, described passing over a headset as the current practical method, but this interrupted the wearer, required adjustment, and left the giver unable to see “*what they’re doing*.”

5.1.2 Showing a Personally Meaningful World and Exploring Others’ Worlds. Personal environments attracted interest as expressions of the people who inhabited them. PC04 imagined a world “*totally custom and reflective of me*,” and PE07 described another person’s environment as “*a metaphor of how she thinks*.” These visits mattered because of the host: as PE05 asked, “*If that person were no longer there, what would be the point of my visit?*”

5.1.3 Scenarios and Activities for Sharing. Participants proposed the following activities:

- (1) **Sharing VR/MR games.** Several scenarios began with an activity rather than an environment to display. PC01 imagined a one-on-one game that “*involves both of you*” and “*strengthens that connection*,” while PC12 imagined “*traveling together somewhere*” while remaining co-located. The reason to cross was to take part together; the destination supplied the setting.
- (2) **Sharing spatial memories.** Participants also imagined making a remembered place available to someone else. PC05 described a valley whose captured depth and light could communicate “*the feeling of being in that valley*.” The value was letting another person explore the setting of a memory, rather than only hearing its description.
- (3) **3D demonstrations and collaboration.** Other proposals concerned ordinary work and learning. PC09 imagined a brief “*come take a look at this*” invitation, PE12 a shared “*Unity scene*,” and PC10 demonstrations at “*Comic Con, animation fairs, or industrial conventions*.” Here, crossing made spatial work available for inspection and discussion.
- (4) **Shared experiences in care settings.** A smaller set of proposals concerned hospital stays, clinical encounters, and isolation. PC11 recalled being in hospital as “*a pretty boring experience*” and imagined shared experiences in that setting. PE01 expressed a wish “*to connect with the inner world*” of a person with chronic pain. These accounts extend the situations participants considered worth exploring; they do not provide evidence of therapeutic effects or clinical suitability.

5.1.4 Reasons Against Interpersonal Sharing. Participants also identified content, moments, and places for which interpersonal sharing would be unwanted or unnecessary. Privacy was one reason: PE04 “*wouldn’t want to show you my virtual white rabbit*” to a stranger, and instead imagined offering “*the living room*.” Interruption was another: PC05 wished for “*an extra gray box*” in which to put an unwanted visitor. Some participants questioned the value of visiting at all. PE12 asked whether a layer serving only its wearer needed to be shared, and PC12 saw little reason “*to go somewhere else*” in a shopping mall because “*you’re already in a different environment*.”

Other settings suggested a different organization of sharing. At an expo or convention, PC09 expected “*a public layer that’s set up by the organizer*” rather than attendees “*walking around the convention in their own world*.” Participants could therefore see value in shared MR while finding one-to-one interpersonal crossing unnecessary as the default. Across these accounts, a visit needed a purpose through a person, activity, memory, or piece of work; where that purpose was absent or the invitation unwelcome, “*you always have to have an option to just not share*” (PE08).

5.2 RQ2: How to Cross? Experiencing MenuPort and TouchPort

The two protocols were experienced as different social arrangements. The handshake made sharing feel interpersonal; the UI menu made the decision feel individually controlled and less socially exposed. Participants valued both qualities, so preferences changed across entry and exit, relationships, and settings. The survey and interviews show that wanting to share, feeling connected, and being willing to touch were related but separable decisions.

5.2.1 Comparing MenuPort and TouchPort. We compare the two protocols through questionnaire results, participants' experiences of the handshake and portal, and their accounts of refusal and exit.

Questionnaire results. In the forced-choice items (Figure 6), all twelve chose the handshake for a stronger sense of being together, eight chose the UI menu as more respectful of personal space and boundaries (2 handshake, 2 no preference), overall preference favored the handshake eight to three (1 no preference), and naturalness for consent was split six to four (2 no preference). Closeness (Figure 7) rose from 2.5 to 4.0 after the handshake and to 3.4 after the menu; eleven increased after the handshake and seven after the menu. On seven experience items (Figure 8, right) the methods were close, with the clearest gap in exit awkwardness, rated higher for the handshake (3.17 vs 2.25). Across ten contexts (Figure 8, left), the handshake was favored only among family and friends and at home.

Connection and control. Participants experienced TouchPort as more connecting, consistent with the forced-choice item and closeness scale, while MenuPort allowed decisions with less direct social exposure. PC09 captured the tension: they were “*more comfortable with the touchless initiation*,” although “*the touch version does make me feel more connected*.”

Relationships and occasions. Preference also moved with who the other person was and where the encounter took place. Willingness to share was high in many contexts; the method changed. The handshake was favored only among family and friends (Mean = 5.67 vs 4.92) and at home (Mean = 5.42 vs 4.58). Everywhere else the menu led, and in hospitals and job interviews eleven of twelve rated the menu higher (Figure 8, left). Interviews showed the same switch within individuals: with friends, touch was unremarkable; with strangers, “*it’s still weird to touch people you don’t know*” (PC03). PC05 preferred gestures “*with people I’m close to*” but the menu “*in shopping malls or hospitals*,” even while willing to enter a clinician’s view of a scan. PC12 summarized the asymmetry: the handshake is for “*the person you know*,” whereas “*the menu item can work for any kind of scenario*.”

Willingness to share, felt connection, and willingness to touch. Wanting to share, acknowledging that the handshake felt more connecting, and being willing to touch were separate matters. PC10 found “*both systems can work for different kinds of people*” while being “*not a very big fan of body touching*”; a Study A questionnaire response described being “*conscious about touching the other because we were strangers*.” For some the three coincided, so that someone “*I don’t want to touch*” was also someone “*I probably wouldn’t invite over anyway*” (PC07). For others, such as PC05 at the hospital, the purpose of sharing survived while willingness to touch did not.

5.2.2 Experiences of Handshake-Based Sharing. Participants described the handshake through physical action and interpersonal meaning. Contact, coordination, and a visible digital response made the opening feel jointly produced, and prompted ideas for other gestures, personalized sequences, and encounters that could leave a trace.

Physical contact and jointly accomplished action. The digital response gave participants a visible consequence for something done with another person. PC04 contrasted the menu, where “*it just happens in the middle*,” with touch, where “*it really feels like I created something*.” PC10 described contact as producing “*the sense we are connected right*”

Comparisons Between The Handshake And UI-Menu Methods

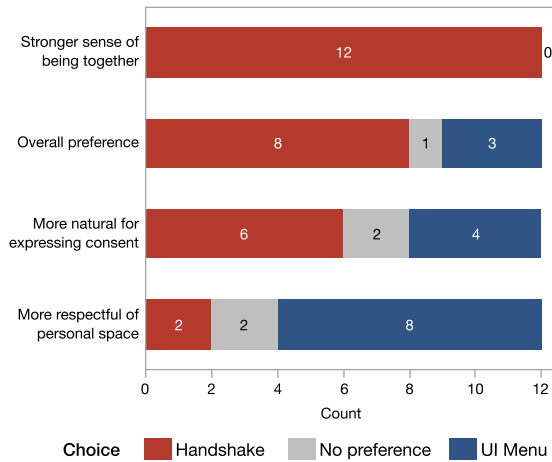


Fig. 6. Comparative choices from the twelve Study A participants. Handshake refers to TouchPort and UI menu to MenuPort. All 12 participants reported a stronger sense of being together with the other person under the handshake, while 8 of 12 judged the UI menu more respectful of their personal space and boundaries. Overall preference and the perceived naturalness of expressing consent were more evenly divided.

Self-Reported Closeness Before And After

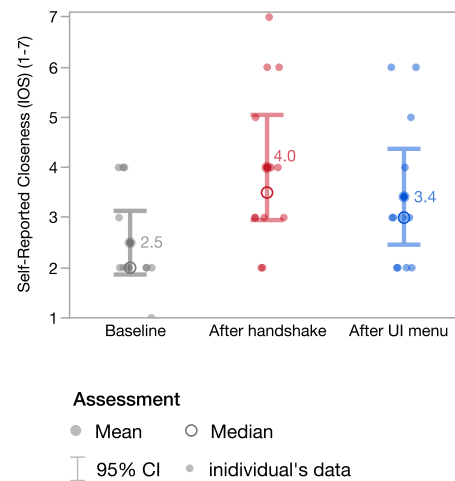


Fig. 7. Self-reported closeness on the Inclusion of Other in the Self (IOS) scale for the 12 participants, measured once before either protocol and after each protocol. Handshake refers to TouchPort and UI menu to MenuPort. Protocol order was counterbalanced.

now,” after which “*the visual enhances the idea.*” Coordination was central. PC01 described the handshake as “*we did something together and we’re sharing reality,*” whereas “*pressing buttons together feels like a disjoint effort.*” PE04 wanted the shaking movement rather than contact alone because the two people were “*working on the connection together.*” Reciprocity could also be experienced as control. PC09 felt that they were “*physically agreeing to open something up.*” Unlike the pressure described in Section 5.2.4, the other person’s participation here made agreement tangible.

Interpersonal attention and the action of welcome. The handshake directed the action toward the other person. PC01 contrasted habitual button use, “*You press buttons all day on your phone,*” with a gesture that felt like “*we’re in this together now.*” PC05 likened the menu to “*a notification with a vibration*” and the handshake to “*a spontaneous desire to share.*” The gesture also brought existing meanings into the encounter. PE10 described touch as “*this moment of agreement or acceptance of each other.*” For PE04, the other person’s physical presence mattered because “*he can actually shake my hand.*” The action fitted especially well with invitations into personal content. When sharing “*a dream that I had,*” PC07 would “*much more want someone to walk into it than press a button.*” The bodily invitation and spatial entrance together made the visit feel like welcoming someone. Descriptions of intuitiveness concerned this fit as much as convenience. PC04 valued being able to “*just walk up to them,*” and PC06 appreciated not remembering a sequence of buttons. PC07 qualified the point: “*it wasn’t so much convenient*”; rather, in MR, “*I expect that it’ll be physical.*” Participants’ accounts did not establish that bodily entry was faster.

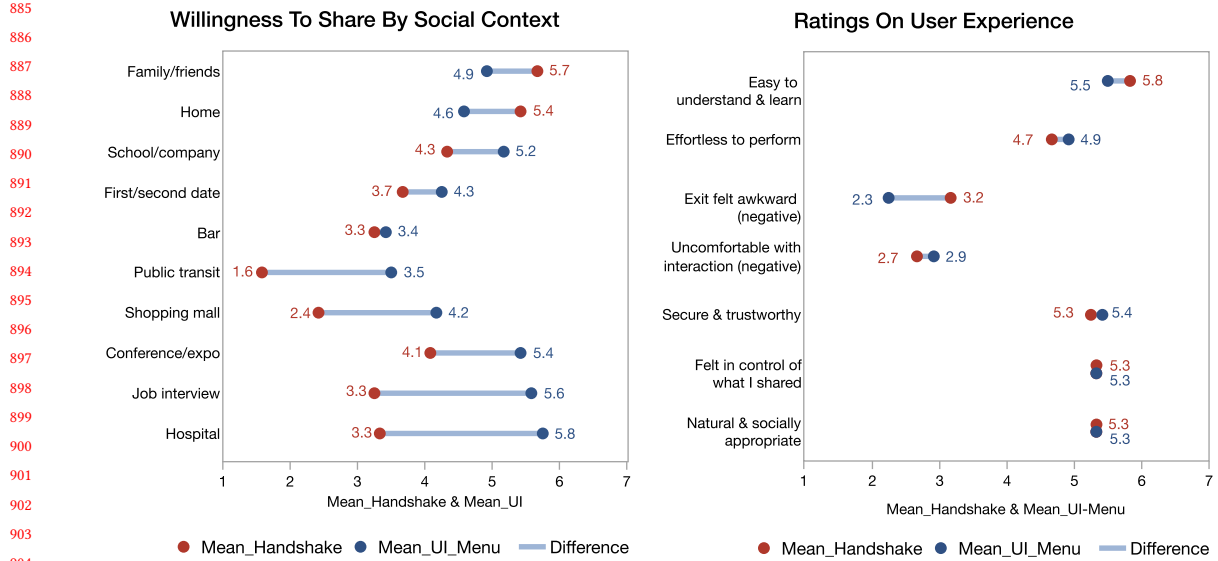


Fig. 8. Study A mean ratings on 1–7 scales: willingness to share in ten contexts (left) and seven user experience items (right), with twelve participants. Handshake denotes TouchPort and UI denotes MenuPort.

5.2.3 The Portal’s Role. Participants attributed qualities to the portal that were distinct from the handshake. It let them inspect a destination, experience passage between environments, and perceive an ongoing connection, while still leaving uncertainty about whether both people had entered or could see the relevant content.

Previewing before entering. A visible opening allowed participants to look before committing to a visit. PW01 described “a window, so I can poke my head through but can’t fully go through yet.” PE04 valued being able to inspect the destination and still “choose to decline.” The portal made looking and entering distinguishable moments in the experience. An opening could make a destination available without requiring the visitor to pass through immediately. Participants could therefore value the invitation while wanting a further opportunity to decide after seeing what it offered.

Continuity between environments. The portal preserved a visible relationship between origin and destination. PC06 experienced the UI condition’s direct switch as being “pulled out” of an environment, whereas a portal “would protect the integrity of both spaces” because “I simply entered another room.” PC03 described a reciprocal quality: “it’s not just me inviting someone into my house, but their house comes into my house.” The opening made the other environment present at the boundary of one’s own. The continued opening also allowed movement back and forth. For PC06, “the portal is there and it tells you” where you are; PC10 took its presence to mean “there is still a connection.”

Knowing what was shared. However, knowing that a connection existed did not always establish what the other person could see. PC05 could not “definitively determine whether it’s within my own space or not.” Discussing collaboration, PC06 felt that mistaking whether another person was in one’s space “would be unacceptable in a group meeting.” PC05 described sharing as adding “an extra layer of verification. Have you entered my world? Have you seen this?” In this respect, PC06 preferred the menu condition’s definite transition, comparing it to checking in a video call

“*that everyone has seen my green page.*” The qualities valued in a personal visit and a work discussion did not always align. Participants’ alternatives further distinguished the portal from its trigger. PC09 proposed “*a UI that triggers a portal, and then we do the rest as in the gesture,*” retaining preview and walking through while changing how the opening was initiated.

5.2.4 Rejecting Invitations and Ending Sharing. Participants placed the ability to say no at several points: avoiding discoverability, declining an offered action, choosing what to disclose after greeting someone, and stopping after connection. Their proposals combined technical controls with familiar social responses.

Availability settings before an invitation. PE09 wanted a decision before any particular invitation. They borrowed AirDrop’s settings of “*off, share with everyone, and contacts only,*” and proposed being unavailable by default, enabling sharing “*only when you feel relaxed and you want to be social.*” Always-on discoverability was compared to “*streaming your Bluetooth open to everyone.*” This addressed who could initiate a digital approach and when, separating general approachability from answering someone already offering a hand.

Declining and deferring an invitation. Some participants expected refusal to work through ordinary bodily cues. PE07 described withholding contact: “*the only way to avoid giving consent is not to touch their hands. People will get that cue very, very fast.*” PE06, PE08, and PE09 described turning away, folding the arms, or leaving; PE11 proposed verbal deferral: “*oh, I’m not ready yet.*” Other accounts emphasized that an available refusal was not necessarily easy. The pressure associated with an extended hand could make deferral useful, and PC08 described “*walking out*” as “*a bit more polite*” than pressing a button. The same reciprocity also made refusal public. Participants described the pull as almost reflexive: it “*in some sense makes you reply,*” and resisting “*makes you a little bit uncomfortable*” (PC12). Declining a hand meant being “*not polite,*” whereas to “*silently click decline*” was “*not at the same level*” (PC11); PE04 expected that faced with an offered hand “*one might reluctantly give in.*” The menu let a person set their own pace and reserve the right to reconsider, as PC12 noted: “*what if I have second thoughts... with a shake I can’t take away the sharing.*”

Confirmation when establishing a connection. PE08 proposed “*two-time consent*”: the handshake could remain “*a physical normal hey hi,*” followed by “*do you really want to share?*” Participants also imagined responding through a choice of destination: PE08 proposed a “*pseudo layer,*” PE04 a neutral room that “*doesn’t reflect my own personality,*” and PC05 “*a facade project that I can show him.*” These proposals let someone acknowledge an encounter while withholding personal material. Gestures themselves were proposed as destination choices. PE04 associated a fingertip touch with “*a common room,*” a handshake with “*my secret room,*” and a high-five with “*my game,*” while noting that mismatched gestures “*would be rather awkward.*” The appeal of meaningful choice therefore depended on mutual recognition of the action.

Difference between entering and exiting. Some participants who happily entered through a handshake did not want to leave through one, and the reason was not only the discomfort of a second touch. It was that the gesture’s meaning ran the wrong way. “*Touching someone means you should be getting closer,*” so closing by touch “*doesn’t make sense*” (PC03). Participants PE10 imagined that a closing handshake was “*not in the story of the handshake,*” and ending through the menu “*preserves the handshake to be a true magic moment.*” One Study A questionnaire response simply did not want “*to touch the other person again*” in order to stop. Study A also recorded higher mean exit awkwardness for TouchPort. PC06, who accepted a handshake exit among friends, still wanted a second route, “*more polite but slower*” beside “*pull the plug.*” Some participants proposed mutual gestures that better fit farewell, such as waving “*to each*”

other for a while” (PC10) or “a high-five as a finishing move” (PE10). These proposals distinguish gestures for entry and farewell, and place individual stopping alongside a mutual ending.

Independent withdrawal after connection. After connection, participants wanted to end their own participation without renewed contact. PC03 stated that “*Having the control yourself gives you the most agency to end something,*” while PC09 felt less secure when stopping required the other person’s agreement. PE04 objected that the prototype “*requires the other person to allow me to return to my original room.*” This describes PE04’s understanding of a dependency on the partner; Study A’s implementation distinguished walking back from closing the connection (Section 3.3). Proposed alternatives included a hardware control “*as immediate as the iPhone’s mute button*” (PC06), a double tap or voice “*safe word*” (PE07), and a menu exit. PC03 also suggested warning the other person, such as “*session ending in 3, 2, 1.*” These accounts distinguish personal stopping, coordinated ending, and notification.

Letting social strategies handle it. Participants did not agree that every unwelcome interaction required a technical response. PC06 argued that an unwanted visitor “*isn’t an issue the space should solve,*” pointing to familiar strategies such as “*ignoring them.*” In contrast, PE11, imagining a gallery where people had already opted in, “*didn’t really know how I would say no.*” These positions locate the problem across interface controls and social expectations. Having opened a connection did not settle every subsequent decision: participants still wanted to choose what to reveal, whether to continue, and how to end the encounter. The comparison shows why neither protocol can be evaluated by efficiency or preference alone. Designs for interpersonal sharing need to treat the purpose of sharing, the desire for connection, and willingness to touch as related but distinct dimensions.

5.3 RQ3: What Does Crossing Open Up? Multiple Layers, Social Meanings, and Personalized Gestures

Participants proposed activities that crossing could support, described how personal and public layers would be organized around them, and described social meanings associated with the experience. They also imagined personalized gestures and souvenirs. The following accounts distinguish these possibilities from sustained practices that were not studied over time.

5.3.1 Multiple Layers Associated with One Person. Participants also described maintaining several environments rather than one. The workshop distinguished “*a place to relax*” from a workspace (PW03). PE10 imagined decorating differently for friends and a supervisor, while PE04 expected to “*show different layers to different people.*” These examples concern preparation for different encounters, not only visual variation. Choosing a layer can frame the visit as a work discussion, a personal invitation, or a shared activity.

This extends the reasons for sharing in Section 5.1. The value of a work demonstration comes from discussing the relevant model; the value of visiting a friend’s environment can come from what the place expresses about that person. If one person maintains several settings, an invitation must specify not only who is offering access, but what kind of visit is being offered.

5.3.2 Connecting Public and Personal Layers. Public-event scenarios introduced another organization. PC09 expected an organizer-provided layer at a convention, with later invitations into specific demonstrations or visits. Interpersonal crossing would then move from a common public setting into a more specific encounter, rather than making every attendee negotiate one-to-one access from scratch.

This distinction also separates responsibilities: an organizer might establish the public layer, while an exhibitor or individual determines the content and terms of a particular visit. The account of intent inclusivity by Hu et al. [61] is

useful here because it includes participation, observation, and avoidance. Layered co-presence could support those intentions spatially: people may inhabit a public event without accepting every personal invitation, and cross only when a specific activity gives the movement purpose.

5.3.3 Social Meanings and Occasions for Contact. Some participants described the experience as supplying a reason to touch. PE03 called it “*a language for touching hands*” in an east-asian cultural context where such contact was uncommon; PE07 felt it “*gave people a little bit of reason to touch each other*.” PE10 and PE11 connected this to post-pandemic hesitancy about handshakes, suggesting that the shared activity could give contact a new meaning.

Participants did not assign the same meaning to every action. PE08 associated a handshake with “*something very formal or an interview*” and a fist bump with being “*more friendly*.” PE10’s distinction between opening with a handshake and finishing with a high-five similarly connected gestures to different moments in an encounter. These proposals treated the action as part of what people were expressing to one another.

5.3.4 Personalized Gestures and Imagined Rituals. Several proposals moved beyond familiar gestures to interactions for particular people. PE12 imagined sequences such as “*first knock, then shake hands, then a secret handshake*,” so that “*only the intended user can open the door*.” The specificity mattered as something associated with the people who knew it.

PE02 imagined custom handshakes that would “*generate different souvenirs*,” particular to the people and place. Workshop participants likewise imagined environments carrying the consequences of encounters: PW04 described “*different versions*” associated with different people met, while PW01 imagined a received memory that “*does become mine, but it’s like a copy or shared memory*.”

We also observed participants initiating handshakes after sessions and joking about using a handshake in ordinary reality to “open” something. This informal observation records a brief continuation of the experience’s associations beyond headset use.

6 Discussion

6.1 A Generative Design Space of Spontaneous Crossing between Mixed Realities

Participants’ revisions to the protocols are useful because they separate choices the prototypes had combined. A menu action could open a portal; a handshake could begin a visit that either person later ends alone; a greeting could precede a separate decision to share. The handshake made invitation and reciprocation bodily apparent, the portal offered preview, threshold, and continuity, and individual controls supported decisions someone needed to make without coordinating a second action with their partner. These recombinations point to a design space for crossing protocols, which we organize through Why, How, and What: why a visit is worthwhile, how it is negotiated and performed, and what it opens up. In the terms of Research through Design articulated by Zimmerman et al. [142], the artifacts contribute through the knowledge their development makes available: here, the choices and dependencies that can inform further crossing protocols. This is an author synthesis of participant accounts, implemented configurations, and prior research.

6.1.1 Decisions Across an Encounter. Evans et al. [38] treat host and guest journeys as parts of a socially organized visit, and their concept of exvitation identifies the permission to leave. Building on that lifecycle perspective, we organize the decisions the enactments raised into the seven stages shown in Figure 9. The stages locate decisions within an encounter; they do not prescribe seven interface steps.

Separating preview from crossing clarifies the portal’s role. A visitor can inspect an opening without yet entering, whereas a direct transition makes entry coincide with acceptance (Section 5.2.3). Work scenarios may favor prompt

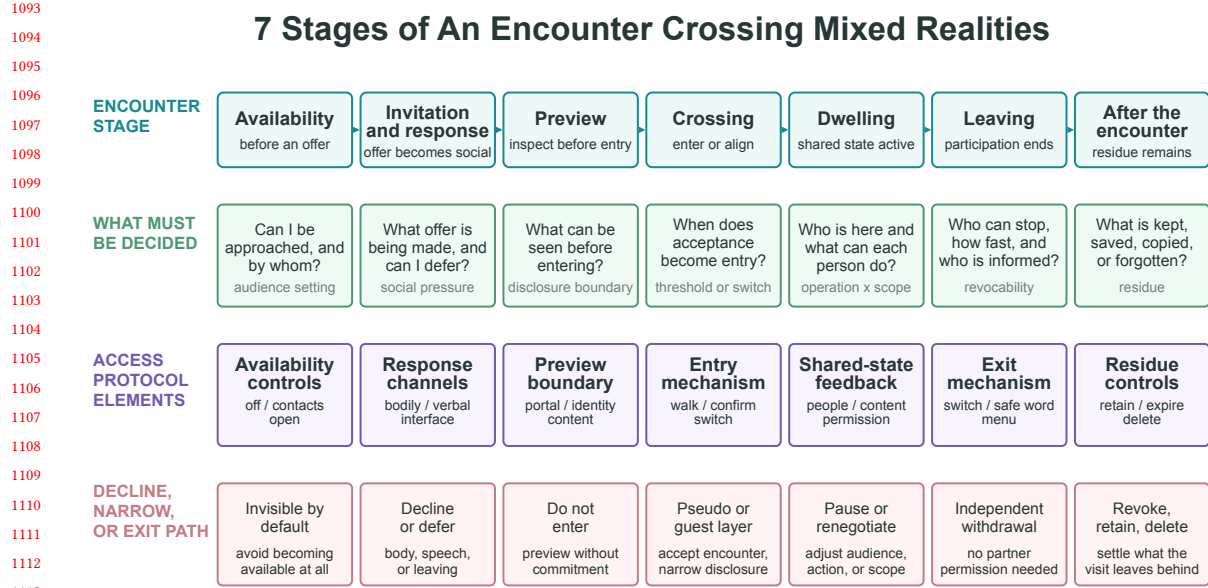


Fig. 9. Seven stages of an encounter crossing mixed realities. Each stage pairs the decision it raises with the access-protocol elements that could carry that decision and with a route to declining, narrowing, or leaving. The stages are an author synthesis of participant accounts and the implemented protocols; Appendix D sets out the corresponding access attributes.

alignment; personal visits may benefit from preview. Wang et al. [138] similarly treat arrival as a negotiated decision, though crossing adds the question of what entering an experience enables. Dwelling needs feedback of its own: a visible portal can communicate where two environments meet without establishing who has access or whether both people see the intended content, echoing transparency concerns in dyadic AR interaction [23]. Availability and refusal belong to the same sequence, since participants wanted to stay available for one activity while declining another (Sections 5.1.4 and 5.2.4).

6.1.2 What Access Allows. The stages explain when decisions arise; acceptance still leaves open what has been granted. Rajaram et al. [108] show that multi-user AR sharing techniques must be considered together with the permissions they enact, including viewing, editing, access by further people, and captured information. Crossing brings those concerns into an interpersonal visit and adds questions about gifts, residues, and continuing access, which Appendix D sets out as a set of access attributes.

These distinctions name consequences that a single opening action leaves unspecified. Moving an object and saving the changed arrangement are different permissions; accepting a gift and continuing to reach the giver's environment are different outcomes. Permissions can also change as an activity develops, from looking to manipulation or exchange. PE08's proposal of two-time consent and PE04's association of different gestures with different destinations suggest that such distinctions might be expressed through offers, selections, or agreed actions rather than an extensive settings panel (Section 5.2.4).

1145 6.1.3 *Configuring Different Encounters.* The space is useful when it generates different protocols from the same
1146 components. A personal visit might combine a mutually welcome gesture, portal preview, a place associated with
1147 the host, an optional keepsake, and independent stopping. A work demonstration might foreground the model, the
1148 task, the people joined, and permissions for viewing, trying changes, or saving revisions. A public exhibition might
1149 begin in an organizer layer, then use contact-free entry or embodied invitation for particular works (Section 5.3.2).
1150 Transitional Portals explores participatory co-located passage [107] and Blending Spaces investigates the transfer of
1151 objects between realities [24]; our space asks how such resources could be configured around different purposes and
1152 participation arrangements. The point is not to prescribe these configurations, but to show that trigger, transition,
1153 access, and ending can be composed differently.
1154

1156 Across configurations, entering and leaving remain asymmetrical. The social effort of a joint opening can make a visit
1157 meaningful, but repeating that effort in order to stop made participants dependent on another person at the moment
1158 they wanted to withdraw (Section 5.2.4). Exvitation [38] helps preserve the relational work of departure; our participants
1159 additionally suggest separating that work from the technical ability to end access. A wave or a high-five could mark
1160 a shared conclusion, while an individual control remains available when a coordinated farewell is unnecessary or
1161 unwanted.
1162

1164 6.1.4 *What the Enactments Contributed.* The enactments supplied concrete grounds for these recombinations. Elsdén
1165 et al. [36] foreground participants acting within speculative circumstances that have present consequences. Here,
1166 participants' accounts of invitation, bodily response, and ending concerned encounters with a real partner, even while
1167 everyday personal MR remained speculative. PC09 could propose retaining the portal while replacing its trigger, and
1168 participants could distinguish a valued joint beginning from an unwanted obligation to coordinate the ending. These
1169 accounts connect a particular enacted arrangement to a design choice that participants wanted to change.
1170

1172 Simeone et al. [124] develop immersive speculative enactments to make future technologies and scenarios available
1173 for experience; Cools et al. [25] apply that approach to possible everyday MR contact lenses. Our application uses two
1174 contrasting protocols and an artistic extension to make different combinations of crossing experienceable. MenuPort
1175 gives a recognizable request-and-response path, TouchPort makes bodily coordination and passage tangible, and the
1176 artwork adds visiting and environmental change. Participants' responses support separating components, questioning
1177 commitments, and proposing further activities. The methodological contribution is this account of how enactment
1178 develops the design space; it does not depend on claiming a new enactment method.
1179

1181 The futures made tangible also direct attention. Handshakes, portals, dreamlike rooms, and gifts encourage some
1182 interpretations more readily than others. Dunne and Raby [33] use speculative design to open alternative possibilities,
1183 which motivates keeping those propositions available for rejection as well as elaboration. Participants' accounts of
1184 unnecessary visits and uncomfortable invitations are therefore central results. They identify conditions under which
1185 crossing might need another form or might not be worth initiating. The space remains generative by retaining those
1186 objections alongside the activities participants imagined.
1187

1189 6.2 Crossing Protocols as Ritual Design

1191 The handshake worked as an opening because it is already a social act, not because a system can recognize it. Dourish
1192 [32] locates meaning in the practices through which people act together, and participants read TouchPort's opening that
1193 way: offering a hand, reciprocating, and entering became a recognizable act of welcome. That reading is not universal.
1194 Corfield's history of handshaking [27] traces meanings that developed within particular social settings and differed by
1195

position and gender. PE03 described the work as supplying “*a language for touching hands*” in a context where such contact was uncommon, PE10 and PE11 connected it to post-pandemic hesitancy, and PC03 still found it “*weird to touch people you don’t know*.” The comparison marks the same boundary: the handshake led only among family and friends and at home, and eight of twelve judged the menu more respectful of personal space. One gesture cannot carry a protocol intended for everyone.

Participants, however, did not treat the handshake as the only candidate. They described gestures as a set with different registers and different consequences. PE08 heard a handshake as “*something very formal or an interview*” and a fist bump as “*more friendly*.” PE04 mapped a fingertip touch to “*a common room*,” a handshake to “*my secret room*,” and a high-five to “*my game*.” PE12 imagined “*first knock, then shake hands, then a secret handshake*,” so that “*only the intended user can open the door*.” These proposals vary along two dimensions at once: how much contact a gesture asks for, and how much of a layer it opens. Mah et al. [86] likewise connect bodily action, focused attention, and a designed conclusion, treating the sequence rather than the single movement as the unit of design. A crossing protocol could carry both dimensions in one action, so that choosing a lighter gesture narrows the opening rather than refusing the visit. Cultural and personal comfort would then be expressed inside the protocol instead of as an exception to it.

Three conditions would make such a vocabulary workable. It must stay mutually legible, since PE04 observed that mismatched gestures “*would be rather awkward*” and both people have to read an offer the same way. Contact-free routes must be full members of the set rather than fallbacks, because willingness to share and willingness to touch remained separate throughout our findings. And what each gesture grants must stay visible, or an expressive vocabulary becomes a hidden permission language. That last condition extends past the moment of entry. Klüber et al. [73] design artifacts that mark relationship transitions, and Uriu et al. [134] connect floral offerings to virtual commemoration through SenseVase; PE02’s custom handshakes that would “*generate different souvenirs*” point the same way, and a keepsake carries access questions with it [108, 118], which we develop in Appendix D. Our enactments were brief. Whether people would settle on shared gestures, and revise or abandon them, requires repeated encounters to study.

6.3 Limitations and Future Work

The studies examine an enacted future through prepared situations. Participants experienced supplied environments and a deliberately introduced possibility of sharing. Their accounts support interpretations of those experiences and reasons for imagined future use; they cannot establish how often spontaneous crossing would arise in everyday life. Self-authored or long-inhabited layers could change the stakes of attachment, disclosure, and interruption. Future work should examine invitations that arise during ongoing activities with environments participants have made their own.

The corpus is small and shaped by voluntary participation and professional familiarity with MR, design, and HCI. The formative workshop also included project researchers. The findings do not represent the range of cultural conventions, relationships, abilities, and attitudes toward touch that future encounters could involve. Recruitment beyond these communities, including people who prefer contact-free interaction, would help test the relevance of the proposed choices and identify missing ones. Larger group encounters would introduce participation arrangements beyond the dyadic prototypes.

The comparison contrasts complete protocol packages. Their differences include touch, reciprocal action, portal representation, movement, object transfer, and exit. Descriptive preferences cannot isolate the contribution of any one feature. Participants’ proposals suggest focused next comparisons, including a UI-triggered portal and independently available exit within a jointly initiated encounter. The prototypes also relied on configured devices, shared spatial

alignment, and an application-specific implementation. Platform interoperability, identity assurance, fine-grained access enforcement, and bystander participation require further implementation and investigation.

Finally, short encounters with an artwork can make a possible practice memorable without showing how it would persist. The study did not systematically follow gifts, environmental changes, or gestures across repeated use. Longitudinal work could examine whether people develop shared conventions, how they revise or abandon them, and what control they need over retained traces. The design space offers questions and combinations for that work; its coverage and usefulness remain open to evaluation through further design and situated use.

7 Conclusion

We investigated spontaneous crossing between personal mixed realities through immersive speculative enactments. MenuPort and TouchPort organized invitation, entry, and exit through interface-based and embodied protocols, while *Allow Me into Your Dream* extended TouchPort into an artwork about visiting and gifting. Participants valued purposeful visits and interpersonal connection, and questioned unnecessary access, unwanted touch, and endings that depended on another person's cooperation. Their accounts show why combining protocol actions must preserve decisions about participation: a jointly meaningful opening can coexist with a separate choice to enter, disclose, or leave. From these responses we develop a generative design space connecting purposes and non-participation, the organization of crossing, and the activities it could support. As personal mixed realities become ordinary, how people are let into them becomes a question for design.

Statement of AI Usage

AI-assisted tools supported literature search and language revision. The authors independently verified the relevant claims and references, reviewed all AI-assisted outputs, determined the evidential boundaries of the work, and retain full responsibility for the manuscript and its contents.

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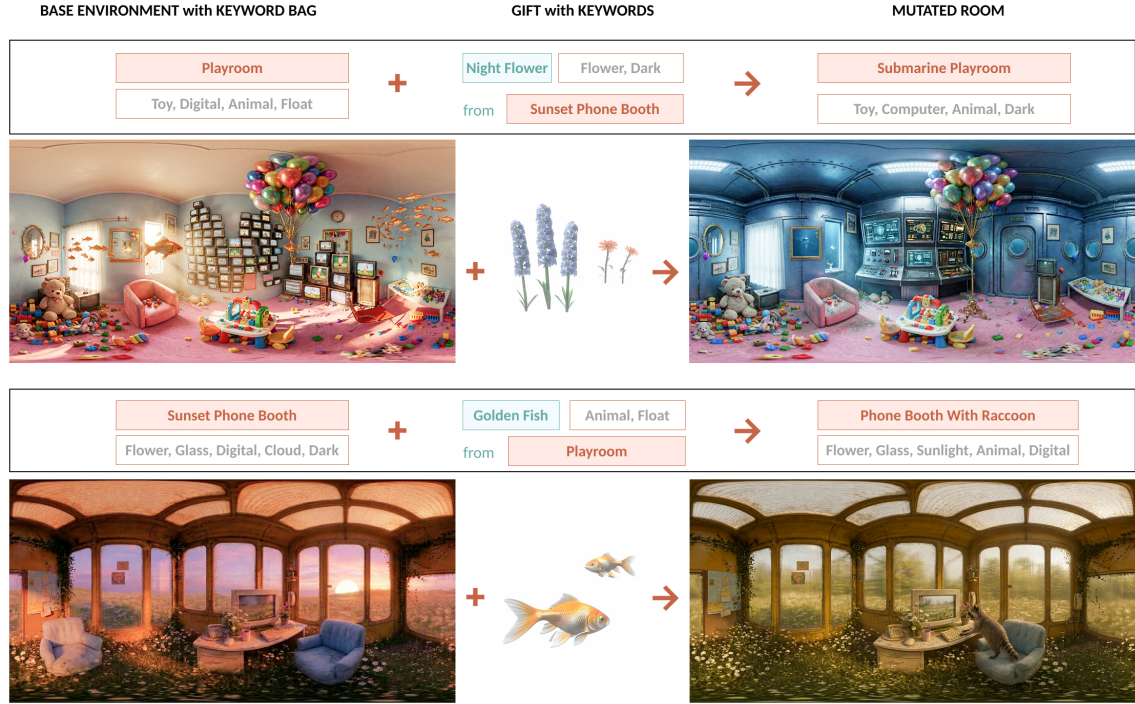


Fig. 10. Examples of the Gift Mutation Grammar. Room and gift keywords combine to select a variation of the receiving environment. These examples describe the artwork's design, rather than measured effects of gifting on participants.

A Artifact Details

Allow Me into Your Dream extends TouchPort through stylized rooms and gift exchange. Each participant begins in a different room over the same physical setting. The room set includes a playroom, a phone booth, and a cloud room. The portal connects these environments, allowing a visit and the passage of an object into the receiving layer.

The Gift Mutation Grammar associates rooms and gifts with descriptive keywords. Combining a room's keywords with those of an incoming gift selects a local variation of that environment. The design preserves a recognizable room while allowing the encounter to change its appearance. Figure 10 illustrates examples, and Figure 11 shows the room relationships. These are artifact rules; participants' interpretations and further proposals are reported separately in Section 5.3.

B Protocol Configuration in Study A

Both comparison conditions used the same MR assets. Sections 3.2 and 3.3 describe what each protocol exposed to participants.

A UI-triggered portal was technically possible but was omitted from the comparison to keep the within-subjects procedure short. It arose in participants' discussion as an alternative configuration. The contrast reported in the paper therefore concerns the two implemented packages, rather than an isolated manipulation of the entry gesture.

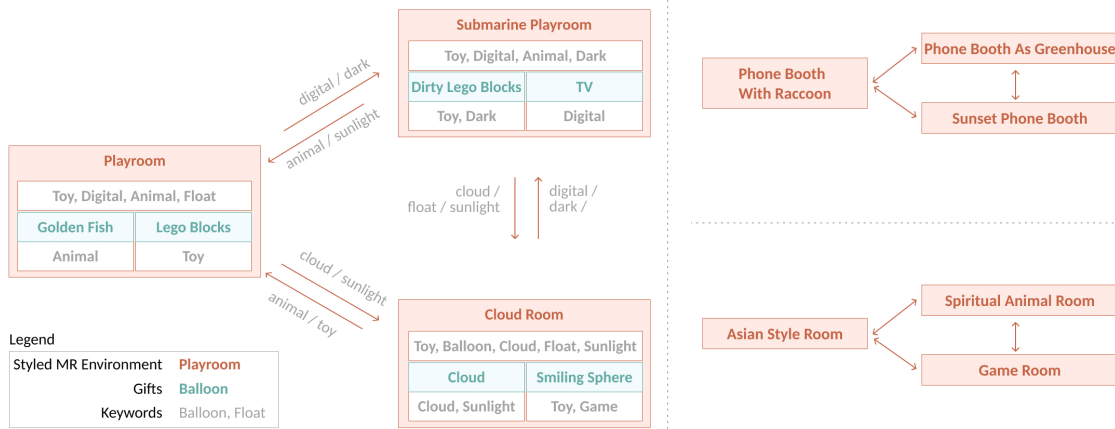


Fig. 11. Room and gift relationships in the “Allow Me Into Your Dream” artwork’s transformation rules. The diagram describes possible transitions within the room set.

C Study Procedure and Interview Topics

The following summarizes the procedures and topics documented for the studies; it is not a verbatim interview script. In the formative workshop, hands-on exploration and a guided body scan preceded narration and collective reflection on future MR encounters. Topics included the qualities of shared experiences, public and private layers, object transfer, and traces of encounters.

Study A used counterbalanced exposure to both conditions, individual questionnaires after each condition, and a semi-structured interview of approximately 20–30 minutes. Interviews addressed the experiences of sharing and crossing, preferences between the protocols, and the suitability of the interactions for different relationships and situations. Follow-up explanations concerned invitation, bodily interaction, the portal, refusal, and exit.

Study B combined paired artwork experiences with interviews lasting 5–40 minutes. Interviews could involve both members of a pair, one participant, or a longer follow-up conversation. Topics included participants’ understanding of sharing, which layers or experiences they would share, with whom and where, and how they would initiate, refuse, or end an encounter. The PC, PE, and PW prefixes retain these different sources throughout the findings.

D Access Questions and Design-Space Provenance

The questions in Table 5 elaborate how access might be configured within the Why–How–What space. The attributes are an author synthesis connecting participant material, artifact mechanisms, and AR permissions research [108]. They are neither an exhaustive interview taxonomy nor a list of capabilities implemented by TouchPort. In particular, possible controls over retained changes and objects require further design.

These questions cut across the functional sequence in Section 3.1. For example, understanding scope can inform confirmation before entry, while revocation concerns permission management during and after sharing. Likewise, availability, invitation, preview, crossing, activity, exit, and residue describe moments in an encounter rather than seven additional implementation steps. Keeping these levels distinct allows one visible action to serve several functions while leaving consequential decisions open to further interaction.

Table 5. Access attributes as questions for further design, with their source in this inquiry.

Attribute	Question	Grounding and synthesis
Scope	Which content or layer is offered?	PE04's alternative destinations and PE08's neutral layer; Section 5.2.4.
Action	What can a visitor do with the content?	Looking, walking, and object manipulation in the prototypes; additional permission distinctions from AR sharing research.
Audience	To whom does access extend?	Relationship-dependent invitations and PC09's public layer; authors extend these to questions about additional participants.
Duration	How long should the connection continue?	Different visit purposes and stopping proposals; time-limited access is a further design question.
Mutability	Can an encounter change a world, and are changes retained?	Artwork transformations; authors distinguish a visible change from a saved revision.
Portability	Can an object leave the encounter or be kept?	Portal-based object transfer and PE02's imagined souvenirs; retention control is prospective.
Revocability	Who can withdraw access, and through what action?	PC proposals for individual stopping and the conditions' different exit mechanisms; Section 5.2.4.
Residue	What remains after live sharing ends?	PE02's souvenirs and PW01/PW04's design reflections; authors extend these to control over traces.