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Abstract

With the ongoing shift into the digital, spontaneous social encounters in public spaces are becoming challenging for adolescents. This study explores how robotic street furniture could facilitate meaningful adolescent social interaction. In a focus group and a theater-based co-design workshop, fourteen adolescents envisioned and enacted ten speculative concepts, such as roaming benches that invite serendipitous meetings. An analysis of these concepts identified diverse roles for robots (e.g., icebreaker, scapegoat) and revealed their particular social strengths and weaknesses (e.g., objective yet insistent). These insights were condensed into eight design suggestions, such as designing robots to orchestrate coincidences or framing them as opponents that humans can team up against. We suggest that robots can facilitate adolescents' social interaction in public spaces, particularly due to certain social strengths inherent in the machinic nature of a robot.

CCS Concepts

• **Human-centered computing** → Interaction design; Interaction design process and methods; Participatory design.

Keywords

Social Encounters, Human-Human-Robot Interaction (HHRI), Robots in Crowds, Co-Design, Performative Methods, Adolescents, Public Space



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1 Introduction

Adolescents rely on urban public spaces as sites for social exploration, peer bonding, and identity work – offering forms of freedom and togetherness that neither school nor the parental home can provide and that are not tied to commercial consumption [19, 99, 122]. Yet they tend to be regulated rather than supported in public space [94]. Since adolescents have little influence on the design of public spaces, their needs, concerns, and social practices are usually overlooked [67]. Unlike digital platforms – where social life increasingly unfolds and where connections often remain filtered, curated, anonymous, or disembodied [63, 102, 121] – physical public spaces enable serendipitous encounters with a wide variety of different people in the form of face-to-face embodied co-presence [26, 97]. These encounters can help counteract loneliness and foster social resilience, which is particularly relevant for adolescents, who are disproportionately affected by digital isolation [24]. Against this backdrop, it seems worthwhile to explore how technologies might scaffold or amplify adolescents' encounters in public space – and how adolescents themselves envision such support.

In Human–Computer Interaction (HCI), researchers have long explored how technologies can foster social interaction in public spaces. Examples range from benches that make heartbeats audible and share them between sitters [62] to socio-spatial interfaces that encourage togetherness between strangers [52]. While such systems can meaningfully shape how people relate to one another, they are typically thought of as responsive infrastructures or forms

of tools: they respond to input but show no own agency: they neither initiate interaction, nor negotiate social norms, or adapt to situations over time. In contrast, work in Human–Robot Interaction (HRI) and Human–Human–Robot Interaction (HHRI) increasingly conceptualizes robots as social actors capable of influencing human-human dynamics in groups and crowds [29, 110, 111, 124]. Yet most of this research has focused on collaborative work and productivity and gives little attention to both the socio-emotional dimension (some exceptions, e.g., [95, 96]) and public spaces. Recent work highlights robots' particular "superpowers" – unique social qualities such as persistence or non-judgment – that may allow them to intervene in social situations in ways humans cannot [38, 125]. However, despite this potential, little is known about how robots could support human–human encounters in public spaces, and almost no work considers how adolescents envision such support.

With this in mind, this paper asks: Could robots – precisely because of their physical presence, agency, and even unique social qualities – improve human-human social interaction in public spaces? More specifically, how might adolescents imagine robots that enable, disrupt, or reshape spontaneous encounters in public spaces? What are the unique social qualities of robots relevant to adolescents, and how can designers make use of them?

To explore these questions, we employ a theater-based co-design approach with adolescents. The focus on adolescents foregrounds the perspectives of a group with limited political agency, revealing what they hope for – and fear – when robots intervene in everyday environments shaped by adults.

Our contribution is twofold: First, we present ten speculative concepts for robotic street furniture – such as benches, bike stands, or traffic lights – co-designed and enacted with adolescents in a participatory, theater-based Research-through-Design process. These concepts allow us to identify the roles that robots are imagined to perform, as well as the social strengths and weaknesses attributed to them. Second, we consolidate these insights into eight suggestions that show how robotic furniture could be designed to support meaningful everyday encounters in public spaces. Alongside these contributions, we reveal adolescents' ethical concerns regarding robots in public spaces and offer methodological reflections on the opportunities and limitations of our co-design approach.

We begin by reviewing related work on social robots for adolescents and robots in public spaces. We then describe our study design, present our findings, and conclude with a discussion that situates these insights within the broader HRI and HCI literature.

2 Background

2.1 Adolescents and Social Robots

Adolescents are individuals in the transition from childhood to early adulthood. They constitute a particularly vulnerable segment of the population. Unlike adults, they have limited access to public life. Many cannot afford to stay in cafés or to visit cultural events due to restricted financial resources [57]. In addition, they are often perceived as a nuisance in public space and therefore regulated [94]. Furthermore, they are not yet entitled to vote, which bars them from formal political decision-making [119]. Consequently, they are largely excluded from shaping the spaces they inhabit.

Compared to other age groups and past generations, today's adolescents experience disproportionately high levels of stress, depression, and loneliness [7]. Research links these mental health challenges to broader risks for democratic participation, as diminished well-being can erode civic trust and engagement [55]. These developments underscore the urgency of involving adolescents in the design of technologies that strengthen their sense of agency, support social interaction, and foster societal participation.

At the same time, adolescents are often seen as tech-savvy early adopters and open to innovation [65]. As the next generation of citizens and decision-makers, their perspectives hold particular significance for shaping the future of human–technology and human-robot interaction. However, adolescents remain an underrepresented group in both HCI and HRI research [7, 81]. Social robotics has largely focused on children [49, 64, 98, 117] or older adults [72], for instance, in schools or in care facilities. Consequently, our understanding of how adolescents engage with and relate to social robots remains limited.

Existing work with adolescents usually conceptualizes the robot in a dyadic mode, positioning it as a companion or coach [6, 7, 82, 88, 101, 113], rather than exploring triadic or even multi-party forms of interaction. This is interesting, especially since recent co-design studies indicate an interest among adolescents in robots that support social interaction with other people. For example, in a study conducted during the COVID-19 lockdown, adolescents proposed robots not only as personal companions, but also as a chance to facilitate human-human interaction, such as connecting divorced parents' households [2]. In another study about group work, adolescents used a robot to facilitate group discussions and suggested that robots could help to get to know each other more quickly [50].

A small number of studies explored the participation of adolescents in civic life through chatbots [120] and social robots [67, 73, 74]. For instance, Jarske and colleagues conducted co-design workshops [66] and some of the suggested concepts envisioned robots as facilitators of human-human interaction – for instance, by helping families discuss societal issues or mediating feedback between adolescents and city officials.

The specific intersection of adolescents, robots, and public spaces has been explored by Carl DiSalvo and colleagues through a series of participatory design projects [30–33]. In one project, teenagers remotely operated telerobots in urban environments to experience and better reflect on non-human perspectives on the city [31]. However, DiSalvo did not focus on the robot's potential as a social mediator or facilitator.

As far as we can ascertain from the existing literature, the perspective of adolescents on robots to support social interaction with other people in public spaces remains largely unexplored.

2.2 Robots in (Semi-)Public Spaces: From Functional to Social Roles

Most robots in public space serve functional, not social purposes. These include cleaning [4, 68], trash collection [17, 20], delivery [46], and infrastructure maintenance or construction work [86]. Other robots operate in the domain of safety and governance, including surveillance, patrol, crowd-control, traffic management, or

police robots [22, 114, 132]. A widely discussed example is Spot, the robotic dog deployed to enforce social distancing during the COVID-19 pandemic [89, 116]. Although these systems operate in public environments, they are not designed to engage with passersby. Interactions occur only incidentally, for instance when a person blocks a cleaning robot's path. As a result, research on such robots has primarily examined secondary social effects, including public acceptance, safety concerns, or robot bullying [18, 107, 108, 115], as well as broader ethical implications, including surveillance, spatial inequality, and the exclusion of marginalized groups such as homeless people or people with mobility restrictions [86, 89].

Beyond such functional deployments, a second line of work examines social robots in semi-public environments, such as airports, hospitals, or shopping malls [40, 44]. These systems often use human-like speech or gestures to guide, inform, or entertain people. However, they focus on dyadic interaction with a single user and do not aim to structure human-human social interaction.

A third category consists of robots that evoke group-level or stranger–stranger interaction as an unintended byproduct of their presence. Creative or entertainment-oriented robots such as WallBots, small mobile robots that assist street artists [79] or DRAWBOT, a mobile moving canvas used in shopping malls [66], can attract clusters of onlookers which in turn prompts spontaneous exchanges among strangers. Robots that request assistance from passersby [76, 112, 123, 128] create similar moments of unintended group interaction. A prominent example is HitchBot, the hitchhiking robot that relied on strangers to travel across the country. Although not designed to foster encounters between people, HitchBot acted as a social catalyst and traveling mascot that generated shared experiences, conversations, and cultural exchange across borders [110].

In addition to these incidental effects, a fourth category consists of robots that are explicitly designed to mediate interaction between strangers in both public and semi-public spaces. These social mediators have a wide range of embodiments ranging from humanoid robots to robotic furniture and swarm-based artifacts. Yet they share the goal of deliberately initiating or structuring interaction between strangers. Humanoid robots such as Pepper, for instance, have been used as third-party mediators that initiate small talk [5, 130]. To date, only a small number of roboticized (street) furniture and artifacts have been designed to mediate encounters between strangers. Examples include autonomously moving barstools that reposition themselves to bring strangers into conversation in semi-public bar environments [104], a shape-changing bench tested in different semi-public contexts such as an airport hall [51], and MOSAIX, a swarm of mobile tiles deployed in malls and museums that collects people's viewpoints and clusters into opinion groups to prompt discussion among strangers [1]. In more unpredictable urban public spaces, Woodie, a turtle-shaped ground robot that invites passersby to pause and co-create chalk drawings [60, 61], and BubbleBot, a small toy-like robot that bursts soap bubbles near pedestrians' feet, have been shown to trigger spontaneous social interaction and shared moments among strangers [80].

Together, these projects illustrate early explorations into robots as mediators of social interaction in public and semi-public spaces. Yet such systems remain rare – especially in unpredictable urban environments, where social dynamics are more fluid than in indoor contexts. Moreover, while there are initial calls to include marginalized groups [86, 89], the perspectives of adolescents on robots that facilitate social interaction in public space remain largely unexplored. In the following, we take up this challenge by investigating how young people imagine, interpret, and co-design robotic systems for meaningful social interaction in everyday urban life.

3 Method

To explore adolescents' perspectives on social robots in public spaces and to capture participants' imagination and lived experiences, we combined co-design with theater-based enactment. The following section elaborates on this approach. First, we reflect on our positionality as researchers. Then we outline the method's conceptual roots. Next, we introduce the participants and our recruitment strategy. Then, we detail the three phases of our study: an *exploratory phase* with a focus group and interviews to elicit and empathize with adolescents' experiences in public spaces; a *translational phase* where we turned these insights into design prompts; and an *enactment phase* in which adolescents embodied both robot- and human roles to co-create speculative interaction concepts. The chapter concludes with the analytic strategy, detailing how we abstracted design suggestions from the concepts.

3.1 Positionality

Our team brings together design research, arts-based inquiry, human-computer interaction, and human-robot interaction. The first author facilitated the enactment sessions and has prior experience using theater and improvisation techniques in participatory design. While not trained as a theater practitioner, their familiarity with embodied exploration informed the study design and facilitation. Other members of the team contributed expertise in embodied ideation, community theater, experience design, and social robotics, while acknowledging limited experience with theater. The sessions were additionally supported by an external theater professional who guided movement and improvisation.

As adult researchers whose socio-spatial backgrounds differ from those of the participating adolescents (for instance, some of us grew up outside dense urban environments), we recognize that our generational and experiential distance shapes our interpretations. We therefore approach analysis reflexively, critically examining how our own assumptions inform the meanings we draw from the data. Overall, we approached the enactment not as performers, but as design researchers attentive to the limits of our own perspective.

3.2 Methodological Background: Co-designing Robots through Theater Play

The combination of robots and theater play has a rich tradition. Robots have appeared as entertainers on stage [16, 27, 59] and as part of artistic expression [71]. In design research, theater has been used to explore how robots might move, express themselves, or interact, often through puppeteering [58, 59, 69, 77], collaborations with professional actors or dancers [47, 87], or mixed-reality stages [105]. These approaches typically rely on pre-scripted performances and position participants as observers invited to reflect on what they see [25, 85, 91]. While powerful for examining interaction

design, such formats leave limited room for improvisation, ideation, and for engaging non-experts as active contributors.

In contrast, our study involved participants as co-designers in a design process based on improvisation. The aim was to enable participants to physically and experientially explore possible human–human-robot interactions as they might unfold in situ. This aligns our approach with embodied and speculative design methods such as Bodystorming [109], User Enactments [93], Speculative Enactments [42], and Experience Prototyping [21], all of which use situated enactments to prototype possible futures.

We also draw from Multi-Stakeholder Theater [106] and Stakeholder Drama [23], which use role-play to articulate diverse viewpoints and tensions among stakeholders. Public spaces typically involve multiple actors beyond primary users – including bystanders, passersby, and indirectly affected groups [4, 34, 56, 103, 118, 128] – whose perspectives must be negotiated. Role-play provides a means for participants to inhabit these varying positions [36]. Prior work has shown the value of role-play in human-human-robot interaction and allowed researchers to identify a robot's social roles (e.g., black sheep, ally) and unique abilities (e.g., never offended) in group contexts [38].

Since our study engages with a vulnerable group, our approach also resonates with theater traditions concerned with power and marginalization (e.g., work in the tradition of Theatre of the Oppressed [12]). Although we did not explicitly place our approach within this tradition, there are similarities in the focus on embodied exploration of social dynamics and in enabling participants to reimagine relations and roles.

Finally, participants in our study not only enacted human roles but also embodied the robot itself. This extends our approach toward non-anthropocentric design methods such as Techno-Mimesis [37] and Relational Body Mapping [48], which embody already existing robots to explore subject–object relations. Our focus, however, lies in iteratively imagining and enacting not-yet-existing robots. Nevertheless, we share with this prior non-anthropocentric work a relational understanding of sociability, in which the interaction between humans and robots is not seen as fixed in either party, but emerges dynamically through their mutual engagement [38, 84]. Recent HCI research confirms that theater methods that include the robot's perspective are especially valuable for exploring interaction with robots in public settings [127].

3.3 Participants

Fourteen adolescents (ages 17–20; 10 female, 4 male) from Germany (Table 1) participated in the study. We recruited them via two channels: six through a professional agency and eight through drama clubs of local schools and theater groups – to include a mix of experiences with performance. Seven participants had prior experience with role-play or performance, and none reported prior hands-on experience with robots.

Participants lived in or near a mid-sized German city and typically navigated public spaces independently without adult accompaniment. The group was diverse in in cultural and linguistic backgrounds. Participants noted that cultural background and perceived public visibility shape how they experience safety, belonging, and recognition in public spaces.

The adolescents actively contributed to two phases of the present study: eight participants joined the focus groups and individual interviews, and 10 participated in the enactment workshop. Four individuals contributed to both phases. All participants received financial compensation. All participants – or, for minors, their legal guardians – provided written informed consent. The study received ethics approval from the ethics board of the University of Siegen.

3.4 Study Procedure

Our theater-based co-design study consists of three phases (1). The *exploratory phase* – a focus group and individual interviews with participants – served as input for the *translational phase*, during which we created prompts for the core phase of this study, the *enactment phase.* While the initial phase investigated teenagers' lived experiences in public spaces, the final phase engaged them in imagining potential future interactions with robots through embodied role-play.

3.4.1 Exploratory Phase: Focus Groups and Individual Interviews. To gain a deeper understanding of adolescents' everyday experiences and social interactions in public spaces, we conducted a 90-minute focus group followed by individual semi-structured interviews (approx. 20 minutes per participant). A total of eight adolescents participated in this phase. Discussions revolved around three central questions: (1) What public spaces do you spend time in? (2) What are memorable positive encounters you have had in public spaces? (3) What are negative or uncomfortable encounters you recall? Participants first shared their responses individually using sticky notes, which were then openly discussed in the group. Subsequent one-on-one interviews provided room for more personal reflection: Participants spoke more candidly about their emotions and social strategies in urban contexts.

We recorded the focus group and interviews, transcribed them, and used the transcripts as the dataset for a reflexive thematic analysis [13, 14] conducted by the first, second, and fifth authors together with a research assistant. Our guiding research question was: Which experiences with others do young people perceive as positive and which as negative? We first extracted and collected all reported experiences from the transcripts and independently generated meaning-based codes for each of them. For example, a reflection on reciprocal kindness ("[…] when you receive a compliment yourself, you feel like, oh right, and you're then kind of motivated to approach others and give them a compliment too.") led to codes such as "enjoying receiving a compliment", "having a positive impact by giving compliments", "being inspired by others' kindness". After all four coders independently finished coding all experiences, we collaboratively clustered these codes. Through this process, we developed 18 recurring experience themes – 13 positive and 5 negative ones. Positive themes included "to be brave, push oneself, and grow beyond one's limits" and "to feel proud of accomplishing something together," while negative themes involved, for example, "being misunderstood" or "accidentally behaving inappropriately." To further organize these themes, we drew on Hassenzahl's psychological needs in HCI [54], sorting each theme according to the need it most clearly addressed (e.g., relatedness, popularity, or security). For a complete list of themes, see Table A.1 in the appendix.

Table 1: Demographic overview of adolescent study participants.

Participant	Gender	Age	Prior Theater Experience	Phase 1: Focus Groups	Phase 3: Enactment Workshop
P01	f	20		x	x
P02	f	18	x		x
P03	m	18		x	x
P04	m	19	x	x	x
P05	f	18	x		x
P06	m	17	x		x
P07	f	20	x		x
P08	f	17		x	x
P09	f	18	x		x
P10	f	19			x
P11	f	19		x	
P12	f	18		x	
P13	f	20		x	
P14	m	18		x	

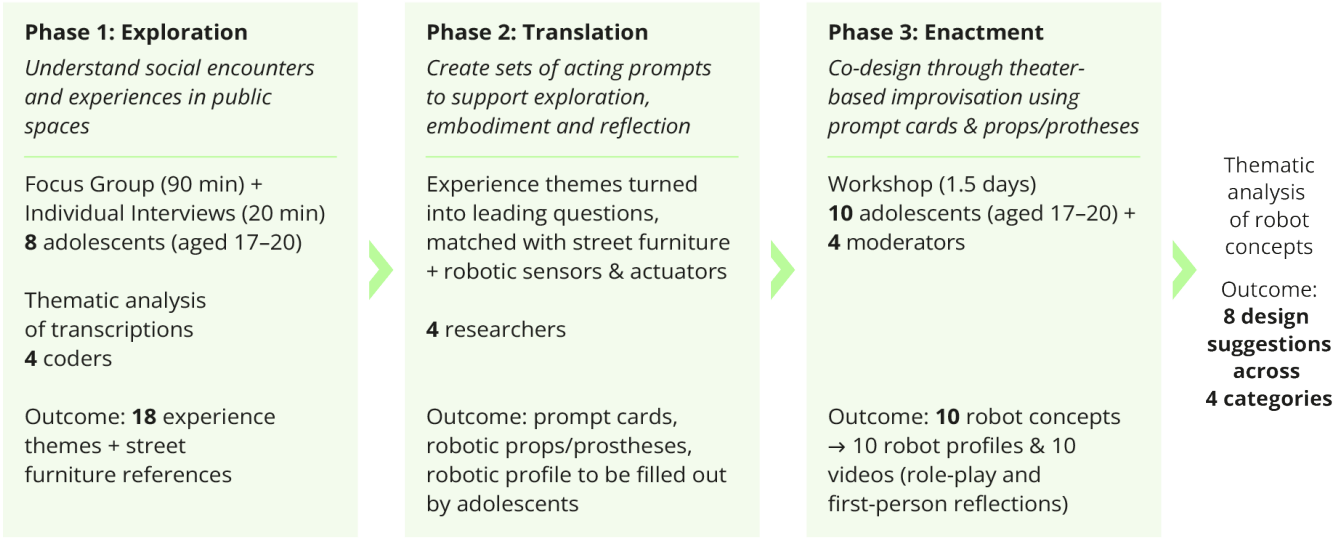


Figure 1: Flowchart of the study procedure.

Since our design space focused on robotic street furniture, we also conducted a complementary coding pass to extract all references to street furniture from the reported experiences – such as benches, traffic lights, and street signs. These two outputs – themes and an inventory of furniture informed the prompts developed in the translational phase.

3.4.2 Translational Phase: Turning Findings into Prompts. Building on the themes derived from the *exploratory phase*, we translated adolescents' experiences into guiding material for the subsequent *enactment phase*: Each enactment began with a set of two ideation prompts (Fig. 2a, b) that differed across sessions, as well as one evaluation prompt (Fig. 2c) that remained identical in all sessions.

To help participants imagine not-yet-existing robots, the first and second authors translated the 18 themes into 14 leading questions. Our goal was to cover a broad range of psychological needs while avoiding redundancy between overlapping themes. For instance, three themes related to helping behaviors ("to help others and offer support", "to be asked for help", "to receive help oneself and experience gratitude" – see Table A.1) were consolidated into the more general question that positions the robot as the agent: "How could a robot motivate someone to help another person?"

Rather than reproducing the themes verbatim – which would not highlight how adding a robot changes a purely human interaction into one mediated or shaped by the robot – we phrased the questions to retain a link to the human-human experiences they stemmed from. For example, instead of asking how a robot might "inspire

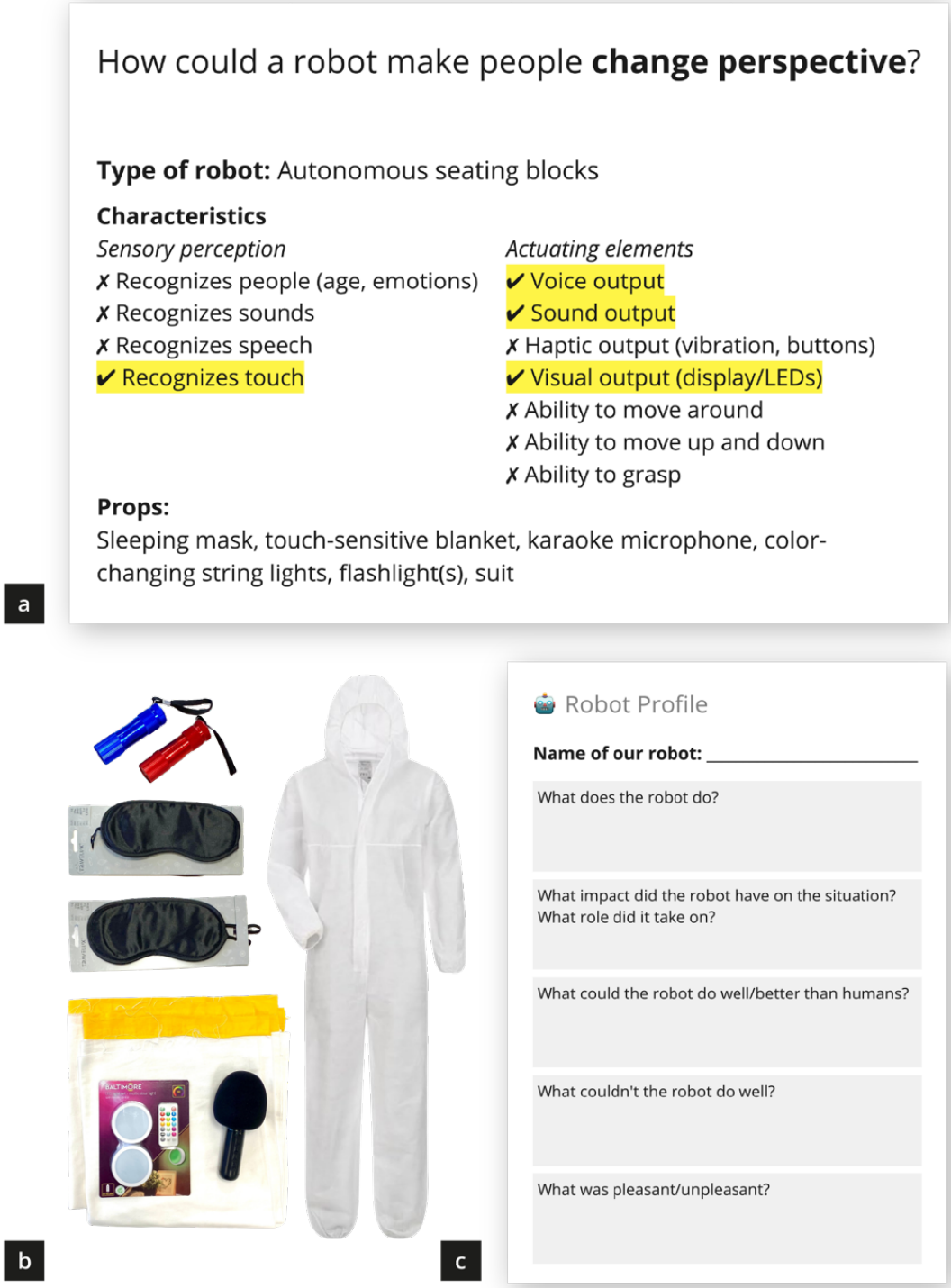


Figure 2: An exemplary starting set for one enactment session. Each set consisted of two ideation prompts: (a) prompt card, (b) robotic props/prostheses, and one evaluation prompt: (c) robot profile for documenting and reflecting on the outcome of each enactment.



Figure 3: Table with Props/Prostheses.

others," we reframed the theme "to be inspired by others" as "How could a robot make people change perspective?"– targeting the human–human dynamics underlying the theme of inspiration. An overview of themes and their corresponding questions is provided in Table A.1 in the appendix.

Next, we revisited our collection of street furniture (e.g., bench, traffic light) and matched each with one of the leading questions. These pairings were informed by the shape, conventional uses, and interactions the furniture affords. After discussing our rationales, we voted on suitable combinations and settled on 10 pairings – for instance, '*Signpost*' + '*How could a robot help people discover or create commonalities?*'

For each combination, we assigned a small set of robotic capabilities (sensors and actuators). These were not intended to suggest technical feasibility but to stimulate varied enactments and encourage participants to explore different interaction modalities. We then translated these capabilities into simple physical props/prostheses that enabled participants to embody and explore a robot's modes of perception and expression – for instance, colored torches for the autonomous traffic light, vision-limiting glasses for a 'non-seeing' seating block, and a wheeled dolly board for a moving, autonomous bench. Our material repertoire aligned with Techno-Mimesis [37], which similarly employs simple props to support bodily transformation from human to robot. While Techno-Mimesis helps participants to experience use cases from the perspective of an already existing robot, our approach begins at the conceptualization stage by using props to ideate. Thus, our initial configurations were introduced only as starting points for co-creation rather than fixed designs: Additional generic materials such as bells, clamps, and gloves provided flexibility for participants to adapt or extend their designs (Fig. 3).

In sum, we created 10 starting sets (cf. Fig. 2 and Table A.2). Each set featured two ideation prompts: (1) a prompt card linking a piece of street furniture to an assigned leading question and introducing selected sensors and actuators, and (2) a corresponding set of robotic props/prostheses. These ideation prompts were grounded in adolescents' familiar experiences while being sufficiently open-ended and slightly defamiliarizing to support speculative imagination [100]. The set was further complemented by a robot profile – a structured form that allowed workshop participants to document, reflect on, and evaluate the resulting robot concept after the ideation took place, by answering the following questions: *What does the robot do? What impact did the robot have on the situation, and what role did it take on? What could the robot do well/better than humans? What couldn't the robot do well? What did you find pleasant or unpleasant?*

3.4.3 Enactment Phase: Designing through Improvisation. For the *enactment phase*, we invited 10 adolescents to a local theater space for a 1.5-day co-design workshop. The sessions took place on a spacious rehearsal stage without natural light and equipped with professional theater lighting, a setting intended to support immersion and imaginative play distinct from conventional institutional spaces. We divided the stage into two dedicated enactment areas, allowing parallel activities to take place. A third area was used to present the available props/prostheses (Fig. 3).

Participants were assigned to two small groups with changing compositions across sessions to expose them to diverse social constellations. Each group was co-facilitated by two moderators drawn from a team including four authors and a participatory theater practitioner specializing in co-creation with youth. The practitioner contributed as a creative consultant throughout the project and was formally compensated for this role.

Over the course of the workshop, we conducted 10 enactment sessions, each lasting around 45 minutes. At the beginning of each session, groups received one of the starting sets (see Fig. 2). One or two adolescents embodied the robot(s) using preselected low-fidelity props/prostheses, while the remaining members assumed human roles. The groups developed each scenario collaboratively, including location, social setting, and the roles of the people involved.

Although the leading question remained unchanged, participants were invited to modify their robot's sensor-actuator setup by adapting the provided props/prostheses. For instance, they chose to equip a seating block with speech recognition – a capability not initially included on the provided prompt card. Reinterpretations enabled participants to spontaneously shape the interaction logic and to explore the consequences of different communicative modalities.

In line with Techno-Mimesis [37], the moderators supported iterative exploration by prompting participants to reflect on their experiences and to compare being a human and being a robot (e.g., "What can you do as a robot that you cannot as a human?", "When

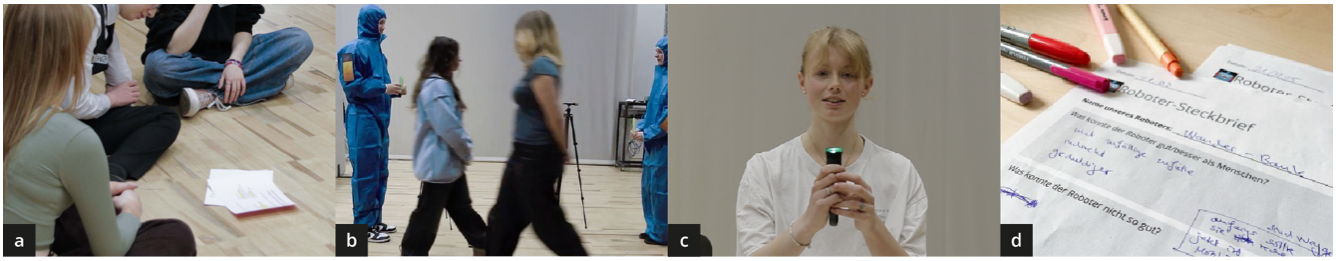


Figure 4: The co-design sessions each proceeded through the following stages: a) introduction and discussion of the prompt card and the included set of props/prostheses, b) ideation through enactment, c) video recording of final role-play and first-person reflections, and d) completion of the robot profile.

would you have preferred being a human in this scene?", or "How would you adapt your robot abilities because of this experience?"). All sessions were video recorded.

Each session concluded with a short final role-play (approximately 5 minutes) and brief in-character, first-person reflections delivered to the camera (e.g., "I'm Emil, 15 years old, and I was just walking through the park when…"). These monologues provided additional insights into how individual participants experienced the social dynamics with the robot. Groups then completed their robot profile documenting the robot concept and its perceived effects (Fig. 4).

Between enactment sessions, the participatory theater practitioner led physical and acting warm-up exercises to help participants – especially those without theater experience – feel more comfortable. Throughout the workshop, we also held two full-group reflection phases, which created space to compare the evolving robot concepts and discuss broader questions (e.g., "Who could be harmed or left out?", "Who would benefit?", "What could be unintended social consequences?"). Participants were additionally invited to comment on their experience with the creative, embodied format.

The enactment phase resulted in 10 completed robot profiles and 10 corresponding video sets, consisting of the final role-plays and first-person reflections.

3.5 Analysis

To move from the adolescents' enactments toward systematic insights, we analyzed the resulting artifacts: the 10 written robot profiles, the 10 corresponding final role-plays and first-person reflections (selectively transcribed), and the fully transcribed full-group reflections. The ideation enactments (i.e., the exploratory parts of each session) were not transcribed but were repeatedly reviewed and informed our interpretations, together with our experiences as facilitators. Following a thematic, interpretative approach inspired by reflexive thematic analysis [8, 13], we focused on how adolescents articulated and enacted roles, strengths, weaknesses, and social effects of robotic street furniture.

We first familiarized ourselves with the material and segmented it into concise descriptive units – expressed as short keyword phrases – that captured key robot attributes (strengths and weaknesses) and perceived social effects (positive and negative).

In the second step, we developed an analysis template (Appendix Fig. A.1) that helped us collaboratively consolidate each robot concept. The template allowed the four analysts to bring together their observations, insights, and interpretations in a shared structure. It captured each concept's title, short description, enacted social roles (e.g., "therapist," "wingman"), and its strengths and weaknesses (e.g., "represent absent people," "non-discriminatory," "indiscreet") linked to perceived social effects (e.g., "connects generations," "raises awareness of one's own limited view"). These descriptors drew both from participants' statements and from our interpretation of the video material. Analysis was carried out collaboratively by the first, second, and fifth authors together with one additional researcher. Each robot concept was analyzed by at least two coders. The goal was not to measure how similarly they coded the material, but to combine their different perspectives and develop a shared, well-grounded interpretation.

In a third step, we derived several initial design suggestions for each robot concept by linking the identified strengths and weaknesses with the identified desirable or avoidable social effects in an instructive paragraph. For example: "Use the robot's ability to engage with emotions without judgment to help people open up," or "Be careful with self-reinforcing dynamics that might lead to prejudices and misinformation." We then clustered these concept-level suggestions across all 10 concepts to identify recurring patterns. Although the resulting eight design suggestions were synthesized at a higher level of abstraction, all of them drew on contributions from multiple robot concepts.

Finally, we analyzed the full-group reflections to understand which robot concepts adolescents evaluated most critically or most favorably, and how they assessed the performative co-design method itself. This material informed findings about ethical considerations, our method, and provided contextual grounding for the design suggestions derived from the enactments.

4 Findings

In the following, we first present the robotic roles, strengths, and weaknesses identified across the 10 enacted street furniture concepts (Fig. 5, cf. Table A.3 for detailed descriptions of the robot concepts). We then outline eight recurring design suggestions that speak to the social potentials of robotic furniture. Subsequently, we present ethical concerns voiced by the adolescents and briefly

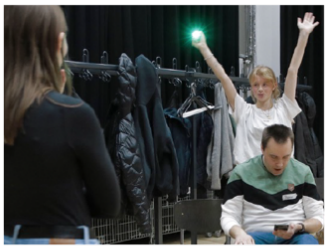
Pushy Bench
Intrusive Matchmaking
Mobile bench that detects loneliness and uses movement and vibration to encourage people to meet each other.



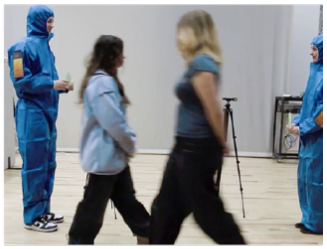
Pushy Benches
Invitation to Serendipity
Network of sightseeing benches that move people around the city, creating repeated and coincidental encounters between them.



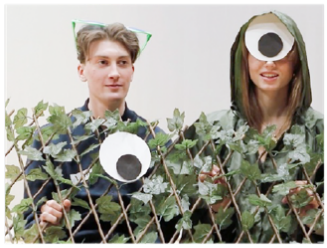
Enlightning Bench
A Beacon of Help
Sensing benches that detect when people sitting on them are in distress and light up to signal that help is needed.



Talking Traffic Lights
Therapy for Prejudiced Signals
Contrasting pair of traffic lights that talk to pedestrians, encouraging them to mediate their inter-robot contradictions.



Intervening Wall
Space for Resolution
Moving wall that detects conflicts and adjusts its position to seperate people, allowing them to calm down.



Reflective Seating Blocks
Seeing through Others' Eyes
Stationary "blind" seats that invite people to share how they perceive the world and to receive the perspectives of others in return.



Playful Bin
An Echo to Cheer on
Interactive trash bin that scans waste, rewards correct disposals or points out mistakes using playful sounds.



Assistive Bike Stands
Human-Robot Network of Help
Networked bike stands that connect cyclists for company, repairs, rentals, and shared activities.



Complimenting Bollard
Filtered Flattery
Mobile bollard that delivers compliments, rephrases them kindly, and blocks inappropriate remarks.



Destiny Signpost
Bridging Paths Together
A signpost that links strangers across locations by inviting them into a playful game to find each other.



Figure 5: Overview of the 10 robotic street furniture concepts that the adolescents conceived in the theater-based design workshop.

describe how they experienced the theater-based method. All participant excerpts are presented in the adolescents' own words, taken from the final role-plays, first-person reflections, and full-group reflections, and are anonymized and lightly edited for clarity.

4.1 Robotic Roles, Strengths and Weaknesses

In the enactments, adolescents imagined robotic street furniture taking on a wide range of social roles. We identified playful roles (e.g., "clown," "game master," "game partner"), therapeutic roles (e.g., "mirror," "transmitter of advice," "helper"), rebellious roles (e.g., "poker face," "trouble maker," "distractor," "scapegoat"), creative roles (e.g., "filter," "ghostwriter"), dependent roles (e.g., "therapy client," "help seeker"), connecting roles (e.g., "wingman," "icebreaker," "bridge builder", "referee"), and functional roles (e.g., "coordinator," "guide," "informant"). These categories serve as a descriptive structure; in practice, adolescents often blended or shifted between roles.

Across these roles, participants attributed distinct social strengths to the robots. They expected robots to exhibit social behaviors that go beyond what would be expected from a human other. They called robots that merely mirror human abilities into question and were more drawn to robots that complemented the participant themselves. As one participant put it: "*What's the point of the robot if it can do everything we can do? (...) I need to feel like I'm still superior to the robot, but at the same time, I also want to feel that it gives me something I couldn't achieve on my own. (...) Otherwise, I'd just think it's kind of unnecessary.*" (P01) Accordingly, adolescents often preferred non-anthropomorphic or non-verbal forms of expression – such as movement, posture, or ambient behavior – over overtly humanlike or verbal interaction. Robotic gestures, subtle shifts, or expressive motions were described as less awkward than humanlike conversational attempts, and often better suited to delicate social situations.

Adolescents emphasized that robots – unlike humans – do not get embarrassed, do not hold grudges, and are not afraid to take the blame. They enacted robots with infinite patience, 24/7 availability, constant politeness, emotional constancy, and the ability to represent multiple viewpoints simultaneously. Robots were imagined as playful, persistent, shameless and socially courageous. As P07 reflected: *"When two people see each other and maybe want to exchange a few words but don't quite know how – it's always a bit of a hurdle. The robot would probably make it easier to take that first step toward each other, and that's why I think it's a really good task for them."* Robots were also credited with selective perception, such as focusing on voice volume while ignoring content – useful in de-escalating a conflict (P04).

A recurring theme concerned the idea of the robot as neutral, impartial, or non-judgmental. Participants described such neutrality as liberating: *"What I liked was that the robot doesn't judge – unlike humans, who often see someone's age or background and immediately start treating them in a certain way. Ideally, the robot doesn't notice what you look like. It just sees a person, a figure."* (P01) Robots imagined as "objective" were also seen as capable of bridging gaps between social groups, for instance by providing context or education on topics such as homosexuality or cultural difference (P10).

At the same time, adolescents discussed clear robotic weaknesses, such as being intrusive, harsh, naive, and confusing. Robots could be tactless or insensitive, as in an example of benches autonomously moving two people face to face, which was described as "creepy, weird, and way too personal" (P01). Adolescents imagined and enacted robots that monitored and spied on others – e.g., by taking pictures without consent – here, shamelessness became a negative robotic trait. Some concepts even discriminated only responding to normative behaviors and people, contradicting P01's earlier desires for non-judgmental robots.

Depending on the context, the same trait could be seen as either a strength or a weakness. Adolescents frequently highlighted this ambivalence: neutrality could appear impersonal or insensitive, shamelessness could become intrusive, and being non-judgmental could slide into naivety or even perceived unfairness. This shows that the adolescents recognized how robotic characteristics can help socially in some situations but feel unsettling or harmful in others.

4.2 Design Suggestions

We derived eight design suggestions from the ten robot concepts. With these suggestions, we translate enacted experiences into actionable yet speculative guidance for future robot designs. We phrased them as clear directive statements to provoke debate, while acknowledging their inherently speculative nature. Rather than prescribing fixed solutions, they highlight opportunities and desirable interaction patterns for robotic mediators that facilitate meaningful human-human encounters in public spaces. In short, they distill how the identified robotic roles, strengths, and weaknesses can be productively leveraged. We grouped the eight suggestions into four categories: facilitate contact and encounter, navigate social tensions and frictions, enable reflection and perspective-taking, and mediate communication and exchange (Fig. 6).

4.2.1 Subtle social affordances to enable self-initiative. Design robotic furniture that gently invites engagement rather than explicitly demanding it. Embed the robot's social role – such as icebreaker, bridge-builder, helper – into a practical function that affords social participation without requiring users to present it as such.

The *Roaming Benches*, for example, first appeared to be sightseeing vehicles, but acted socially as 'wingmen' by moving people into proximity while maintaining the illusion of randomness. This preserved the adolescent's sense of agency and allowed them to take pride in initiating the social contact themselves. As one participant reflected: *"It felt like: I was the one who deliberately decided to get up and talk to that other person. [...] That's what I liked – it felt like I made that moment happen. [..] you could actually take pride in having dared to talk to the other person. The robot lent support, but if it had actively, noticeably done the connecting, it might not have worked."* (P08)

Similarly, the *Enlightening Benches* that lit up when someone needed help acted as social amplifiers – offering subtle cues without actively demanding a response, and thereby enabling adolescents to feel autonomous when stepping in.

The *Assistive Bike Stands* introduced an additional layer: they offered a clear, practical reason for approaching – such as repairing a bike – while simultaneously offering the opportunity for spontaneous interaction with another person through the shared activity of fixing it together. This setup allowed users to connect socially without having to overtly signal their intention to do so.

In contrast, the *Pushy Benches*, which forced proximity and vibrated to prompt conversation, were perceived as overly directive and socially awkward (feelings of being externally controlled and embarrassed) – highlighting that excessive intervention undermines social courage rather than supporting it.

Designs that rely on subtle social affordances respect the user's autonomy and sense of timing. They support social initiative and pride by enabling users to own the moment of connection, rather than feel manipulated into it.

4.2.2 Orchestrated "coincidences" for striking encounters. Create situations that feel like coincidences with robotic furniture – carefully planned yet experienced as serendipitous. Such orchestrations can spark curiosity and invite mutual discovery, laying the groundwork for spontaneous connection.

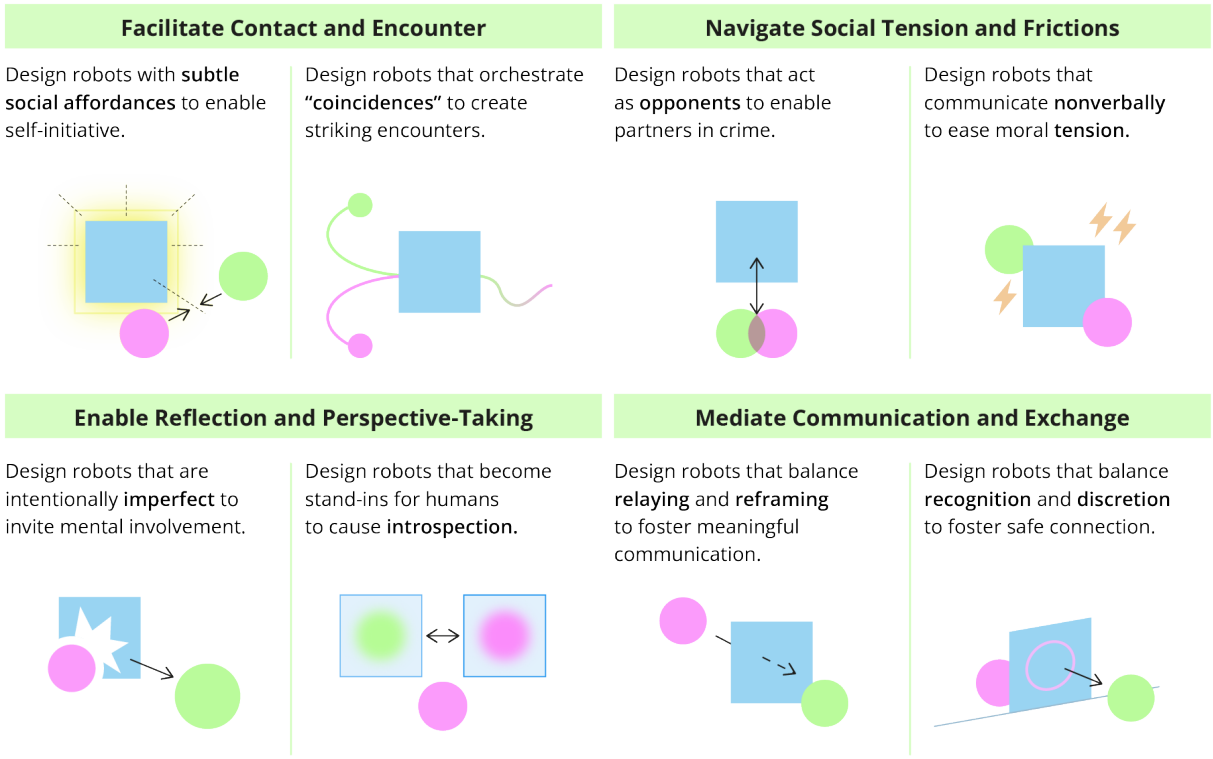


Figure 6: Eight design suggestions grouped into four overarching categories.

The *Roaming Benches*, which appeared to be sightseeing vehicles, acted as poker-faced wingmen, autonomously bringing people into repeated proximity. This prompted a sense of familiarity while leaving the encounter open to individual interpretation. Their social intent remained hidden, preserving users' agency.

In contrast, the *Destiny Signposts* openly embraced their matchmaker role by becoming game masters. Through a treasure-hunt-like sequence, they guided strangers toward each other. Although participants were aware of the orchestration, the buildup still felt mysterious and meaningful. Here, the robotic strength of being perceived as possessing mysterious 'knowledge' ignited the teenagers' eagerness to discover what they might have in common.

Both examples highlight robotic strengths such as being exact in timing and being inscrutable. At the same time, they reveal a tension: if social intent becomes too explicit, the encounter may feel staged rather than spontaneous.

4.2.3 Opponents to enable partners in crime. Design robotic furniture to act as a playful opponent: by behaving unexpectedly or presenting small obstacles, robots can create resistance or mild frustration that, in turn, strengthens human-human social connections.

This design suggestion lies at the intersection of two categories: The suggestion can *facilitate contact and encounter*, but also help *navigate social tensions and frictions* in ongoing interactions.

In terms of initial connection, for instance, the *Destiny Signposts* acted as playful antagonists to the adolescents, presenting riddles that required collaboration between two strangers. The *Pushy Benches* – perceived as overly intrusive – had two adolescents (initially strangers) bond over their shared discomfort and joke about the robot's peculiar behavior.

At the same time, oppositional robots can serve as useful third parties during pre-existing social friction. They can act as scapegoats or distractions, deflecting attention away from human-human tensions. For instance, the *Intervening Wall* stepped into a heated conflict by abruptly expanding and separating two arguing people while additionally emitting loud, absurd sounds. One adolescent turned away from the person they were originally fighting with and started yelling at the robot instead – "Who ordered this thing?!" – prompting both to burst into laughter. This moment of comic relief diffused the tension and opened space for reconciliation. As one participant later reflected: *"The wall was good at redirecting the stress toward something else."* (P07) This unexpected shift prompted the disputants to team up, to unite against the robot and to put aside their disagreement (momentarily).

4.2.4 Nonverbal communication to ease moral tension. Design robotic furniture that interact nonverbally to de-escalate human tensions or gently highlight social norms without moralizing. In public spaces, some situations are morally delicate: when someone litters, shouts, or behaves rudely, a direct intervention – especially verbal – can escalate tension or cause embarrassment. By using nonverbal signals instead of explicit judgment, robots can gently redirect behavior while allowing everyone to save face.

For example, the *Intervening Wall* slowly changed its shape as two teenagers argued. Though it never interrupted or spoke, its subtle movement was enough to shift their attention—and their tone.

The *Playful Bin* took this further. It responded to misthrown trash with humorous sounds and gestures – like spitting the garbage back. In one enactment, an "older man" dropped his trash but could not pick it up. When the bin reacted with an unpleasant sound, two teenagers stepped in to help. The robot became a bridge: Its response triggered spontaneous assistance and created a moment of intergenerational support. Later, the older man reflected that he had felt trapped in the moment and was "super thankful" for the help.

These robots did not demand improved behavior – they suggested it. And precisely because they did not speak, they made space for reflection, amusement, and even solidarity.

4.2.5 Intentional imperfection to invite mental involvement. Robotic furniture does not need to operate flawlessly. On the contrary, designing intentional imperfections can invite people to notice their surroundings, reflect on their own perspective, or even to cooperate with other humans. Robotic imperfection might make human involvement feel both necessary and valuable (e.g., by helping the robot understand or achieve something).

The *Reflective Seating Blocks* are blind by design. They hear and speak but cannot see. This constraint becomes a social affordance: The blocks ask people to describe and evaluate their surroundings ("What do the people around you look like? Do they seem happy?") and gradually shift toward introspective questions ("Why do you dislike people who look that way?"). In this way, the blocks take on the role of a naive yet curious conversationalist. Like a child, they provoke introspection not by judging, but with their strength of remaining neutral and open.

The *Talking Traffic Lights* similarly rely on humans, but in a more playful way. Each traffic light speaks to pedestrians but cannot communicate with its robotic counterpart across the street. Instead, it asks the crossing pedestrians to relay messages to the other traffic light. Its dependent role of a help seeker turns passersby into emotionally involved and invested mediators.

In both cases, imperfection is key. Sensory gaps, skill asymmetries, or emotional naiveté create space for involvement – inviting people to think *with* and *through* the robot, rather than merely responding to it.

4.2.6 Stand-ins for humans to cause (self)reflection. Design robotic furniture as proxies for humans to make human relationships, biases, and social tensions perceivable from a new and more detached perspective. Like fables or allegories, robotic stand-ins can create emotional distance, which in turn allows for deeper (self-)reflection.

The *Talking Traffic Lights* exemplify this. Each light holds its own misconceptions or grievances toward the other light. Passerby become mediators in a dysfunctional relationship between robots. They relay passive-aggressive comments or reframe messages as something more constructive – reflecting, often unintentionally, on their own communication habits. The robot acts as a mirror – though its reflective nature remains hidden until after the interaction. One teenager, for example, described how she noticed a kind of malicious joy within herself when mediating the conflict to the advantage of one of the traffic lights.

Similarly, the *Reflective Seating Blocks* embody a composite voice: they gather, remix, and share what other people have told them before. Speaking from a collective but anonymous "I," they allow people to explore different viewpoints without feeling judged – precisely because the robots remain objective and impersonal. One participant, after discussing a personal conflict with the block, remarked: "Afterwards I thought maybe I was exaggerating." (P05) The robot offered a subtle outsider perspective – reframing the problem through the lens of others living in their immediate urban environment. In this way, the *Reflective Seating Blocks* became vessels for collective insight.

As in these two cases, designers can deliberately draw on the robotic strength of representing multiple viewpoints simultaneously. By standing in for complex human dynamics, robotic furniture creates safe yet powerful opportunities for reflection. Rather than teaching or correcting, lecturing or disciplining, such robots should be designed to mirror, question, and reframe, enabling users to rethink social behavior.

4.2.7 Balanced relaying and reframing to foster meaningful communication. Design robots that can do more than simply relay information. To mediate meaningful communication between people, enable them to interpret, reshape, or even withhold messages. Taking on creative roles – such as ghostwriter or filter – fosters prosocial behavior, but also raises ethical concerns. Designing such systems requires careful attention to how meaning is constructed and received.

The *Complimenting Bollard*, for example, transfers compliments between passersby but refuses to deliver discriminatory or sexist remarks. In one scenario, a teenager – playing an older man – reacted with mock outrage after his inappropriate comment was blocked but later reflected: *"Apparently the robot didn't like that... maybe it was catcalling or something."* (P01) The robot's polite but firm intervention subtly disrupted the social script without outright shaming the user – drawing on its robotic strength of emotional neutrality. Robotic mediators can also promote social inclusion. When a compliment is directed at only one person in a group, the *Complimenting Bollard* generates a second, equally warm message for the other group members – avoiding feelings of exclusion.

Yet, these interventions carry risks. When people feel manipulated or censored, this can erode trust. Even worse, in ideologically homogeneous environments, robots like the *Reflective Seating Blocks*, which repeat user statements, may even amplify existing biases or exclusionary behavior.

These examples expose the tension between robotic strengths – such as politeness, inventiveness, and neutrality – and an inability to exercise contextual judgment. Designing robotic mediators requires balancing influence and integrity: they should foster reflection without deception, remain transparent, and adapt to nuanced social dynamics.

4.2.8 Balanced recognition and discretion to foster safe connection. Social robotic furniture in public spaces must balance two competing needs: the desire to be seen and recognized, and the wish to

remain anonymous or discreet. Some interactions thrive on emotional presence, while others benefit from ambiguity or distance, and designers need to balance both.

This tension became clear in the case of the *Complimenting Bollard*. Some participants valued knowing who had complimented them, hoping for a personal connection. Others preferred to remain unseen, which made the moment feel safer or more genuine. Watching someone react from afar could even create a voyeuristic thrill – raising questions about detachment, social courage, and the ethics of outsourcing personal gestures.

The *Reflective Seating Blocks* also illustrated this balance. In one roleplay, an "older woman" shared advice that the robot could anonymously pass on to others. Indirectness allowed her to offer support without overstepping, while receivers could reflect without pressure to respond.

These interactions draw strength from the robot's infinite patience and 24/7 availability, enabling people to engage on their own terms. Yet their lack of contextual judgment may limit deeper emotional resonance. Designing for adjustable levels of visibility and distance might help foster connection without overexposure.

4.3 Ethical Ambivalence. Adolescents' Perspective on Transparency and Control

In the full-group reflections, adolescents raised several ethical concerns regarding robotic furniture in public spaces and explained which of their concepts they liked best and why. A key topic was transparency: Should robots disclose their social intent? This question was especially prominent in discussions about the *Roaming Benches*, which appeared as sightseeing vehicles but covertly brought people together. While some appreciated this subtle orchestration, others felt manipulated and were uneasy: "With the bike stands, for example, I press a button, and something happens – that makes sense. Or with the partition wall, it reacts to volume. But with the benches, they move on their own, and suddenly I ask myself: why am I talking friendly to this person? That feels a bit creepy." (P04) Another countered that transparency should be optional: "The point of the bench is that you don't know what will happen. (…) But if someone wants to know, they can always look it up – it's not a black box." (P08)

The conversation also touched on ownership ("Is it private, municipal, or federal?") and accessibility. Who benefits from such robots monetarily? Will all users understand them, particularly older or marginalized individuals?

Interestingly, participants expressed the most skepticism toward robots with overtly social functions. Only one person named the *Reflective Seating Blocks* – which share anonymous perspectives and enable indirect local dialogue – as a favorite. A comment on the clearly social *Complimenting Bollard* suggests that participants began to grasp the complexity involved in designing for social interaction: "For me, the compliment robot is the most borderline one. (…) In a way, the idea of people giving each other more compliments is obviously nice. But if it's not done well, it can very quickly become awkward – even for the person giving the compliment." (P10) More often, the most popular concepts were the *Playful Bin* and *Assistive Bike Stands*, which appeared "practical" instead of social at first glance. Yet even here, participants enacted surprisingly social scenarios, in which people helped one another. One adolescent reflected: "I think we liked the trash can and bike stand so much because they let you hide the fact that you're looking for social contact. You don't have to show that you need connection." (P09)

This reveals a central tension: While the participants wanted the robots to be transparent about their social intentions (e.g., the *Roaming Benches*), the participants themselves preferred to keep their own agendas hidden. The desire for plausible deniability may be especially relevant in public spaces, where social vulnerability carries risk. Designing robotic furniture means navigating these asymmetries.

4.4 Methodological Insights From Participatory Techno-Mimesis

During the reflection phase, adolescents described how embodying a robot became easier over time (P10, P08). Several appreciated being able to extend or adapt the provided prompt cards with their own ideas for sensors and actuators (P01, P07). The props and prostheses appeared to support improvisation and foster a sense of ownership over the emerging robot concepts.

Participants noted that while ideation initially felt liberating, sustained improvisation became increasingly difficult; toward the end of the workshop, earlier ideas began to resurface (P08). This illustrates how the method supports rapid early divergence but may taper in novelty without new expert input.

Enactment frequently revealed tensions that had not surfaced in discussion. For example, a group proposed a vibrating bench intended to initiate conversations between strangers. Only during enactment did they recognize the concept as intrusive and uncomfortable, quickly naming it the *Pushy Bench*. Such moments showed how physical acting exposed emotional and social dynamics that remained invisible at the conceptual level.

One participant raised concerns about unnecessarily complex designs: "Why did I make it so high-tech?" (P04). Embodied exploration demonstrated that simple interventions – such as a bench that merely passed by – often produced stronger or more natural social responses than technically elaborate ones. Speech recognition and other complex features were often experienced as overwhelming, confusing or restrictive.

During enactments, adolescents frequently encountered insightful moments of conflict – misunderstandings, hesitations, or emotional discomfort – that did not surface in discussion. These tensions often revealed the strengths and weaknesses of the robots. In contrast, the final role-plays were typically polished, enthusiastic scenarios in which robots successfully resolved social situations. For example, the *Complimenting Bollard* initially created awkward moments of staged flattery among a group of friends – the robot relaying compliments to only one person led to an imbalance within the group. In the final enactment, however, this issue had already been "resolved" by the robot inventing a second compliment for the previously left-out friend. Compared to the exploratory phases, these final staged enactments tended to gloss over the ambiguities and frictions that had emerged earlier, meaning that many complexities surfaced only in the playful, improvisational stages and were largely absent from the final performances.

5 Discussion

Our study examined how adolescents – who are marginalized in public space and vulnerable to social disconnection – imagine robots that shape human–human encounters. Through a theater-based co-design process, participants developed ten speculative robot concepts that enabled rather than replaced social contact, positioning robots as playful matchmakers, naive listeners, nonverbal nudgers, or comic foils. These enactments showed how robots might open, disrupt, or reconfigure social situations. From these concepts, we derived eight design suggestions that outline opportunities for robotic street furniture to support social interaction, grounded in the roles, strengths, and weaknesses identified across the enactments.

Taken together, the suggestions highlight what adolescents themselves regard as supportive for their social lives – for instance, lowering the threshold for initiating contact, navigating disagreement without escalation, experimenting with pro-social "partners in crime," or exploring different viewpoints at a safe distance. Many of these robot-supported practices – perspective-taking, handling conflict, engaging empathetically while retaining a sense of self – are also central to democratic coexistence.

Alongside these opportunities, adolescents' also identified ethical risks. A central concern was the loss of control over social encounters, particularly when robots conceal their intentions or operate through hidden orchestration. Several participants felt uneasy about not knowing whether an interaction was truly spontaneous and self-initiated, or subtly engineered – echoing broader debates about loss of agency, and robotic versus human autonomy [43, 70, 126]. Beyond this, our findings highlight the risk of designing human–human–robot dependencies [11], where humans may begin to rely on robotic mediation at the expense of developing their own social competence. This becomes especially problematic for vulnerable or insecure individuals [75]. Social human-human-robot systems must therefore critically examine whether they support and strengthen an individual's social capabilities – or whether they gradually replace and erode people's agency. These concerns underline the importance of designing robotic systems that complement rather than replace human social capacities.

5.1 Robots with Superpowers Beyond Imitation

Much of the early discourse around social robots has centered on imitation – on making robots appear, speak, or behave like humans [15]. However, recent work in HCI and HRI challenges this anthropocentric framing by introducing more relational and complementary perspectives. Concepts such as "co-performance" [78] or robots in need of help [128] emphasize mutual support between humans and technology rather than substitution, while work on robotic "superpowers" [37, 92, 125] argues that robots should contribute capabilities that humans do not have.

Our findings resonate strongly with this shift. Adolescents did not want robots to mimic them; rather, they wanted robots to complement their human limitations – allowing them to feel supported and superior to the robot at the same time. Robots were valued for their persistence, shamelessness, impartiality, and infinite patience – qualities that adolescents found helpful, yet difficult to embody themselves when facing social tension or uncertainty. When framed like this, the robot is not a social companion that substitutes human interaction, but acts as a social catalyst or a mediator: it supports human-human interaction by nudging, offering subtle social affordances, or even introducing intentional imperfections (e.g., a blind robot that requires human help).

While our findings emphasize how robotic "superpowers" can support adolescents in overcoming social barriers, they also revealed that these traits are not universally beneficial. The same characteristic may function as a strength or a weakness depending on the context. The same shamelessness that lowers social barriers can violate personal boundaries; the same emotional constancy that feels reassuring can appear cold or indifferent. These ambivalences complicate assumptions about robotic social capabilities.

A central tension in our data relates to the aspiration of neutrality. Adolescents often imagined robots as impartial actors that treat everyone "the same," bridge differences between social groups, or counteract human prejudice. Our findings show how robots perceived as neutral can nonetheless monitor, intrude, or discriminate. Neutrality is itself a fragile construct: positioning the robot as an objective mediator risks obscuring the values and assumptions that are built into its design by dominant, privileged stakeholders and may further sideline the perspectives of those who are already marginalized. For instance, robots do not inherently recognize gender, but once gender categories are inscribed into their logic, they may still act in exclusionary or biased ways. With regard to the target group of adolescents, the question even arises as to whether robots should not actually be biased – in order to give a special voice to people who are usually overlooked.

These contradictions point to a crucial insight: robotic traits are not simply given but actively constructed. While robots may appear non-human or objective, their behavior is always shaped by human choices – through sensors, algorithms, interaction protocols, and embedded assumptions. Biases, when embedded in seemingly neutral systems, can be amplified and legitimized – potentially reinforcing inequalities more consistently than human actors would. This highlights how every design choice – no matter how small – can carry social and ethical weight and thus requires careful consideration. Designers must therefore approach such "superpowers" not as universal assets, but as situated potentials – requiring careful attunement to setting, timing, and audience.

5.2 Robots as Situated Urban Actors

Our findings suggest that robots in public space unfold their full potential not only when they differ from humans in what they can do, but also because they differ fundamentally from both AI systems and analog public objects. Robotic street furniture is characterized by two key qualities: its embodied, situated presence and its partial autonomy. These qualities enable interactions that are not only embodied and immediate, but also unpredictable and surprising – making robots fundamentally different from virtual agents or static public objects.

Unlike virtual AI, robotic systems share the same physical space as the people they interact with. Their material presence allows them to participate in the real-time rhythms and unique atmospheres of everyday public life. Just as a well-known tree, mural, or square can gain cultural significance within a neighborhood,

so might a robot – but with the added ability to listen, respond, and adapt. Robots with their physical presence and the ability to respond to external stimuli have previously been described as particularly suitable for engaging with community contexts [33]. Robots occupy a curious middle ground: they are perceived as anonymous, impersonal machines, yet can invite deeply personal or intimate moments, such as an adolescent sharing a conflict with the *Reflective Seating Block*. This duality mirrors public space itself: a place where anonymity and spontaneous intimacy coexist.

Moreover, robotic street furniture is not fully controllable. Unlike traditional tools or fixed urban infrastructure, it can behave unpredictably. While this partial autonomy raised ethical concerns in our study, it also reflects positive effects that both robots and public spaces have in common. Public spaces are inherently uncontrollable. People cross paths by accident, witness behaviors they did not choose, and are exposed to differences and surprises. Because public space is shared, accessible, and collectively controlled, it has long been understood as essential to democratic life [110]. Similarly, in our study, unpredictability was not only seen as concerning but also as enriching – especially when robots enabled unexpected encounters across generations. Participants, for example, described the joy of getting to know another person they did not know they needed in their life at that very moment. This highlights how the uncontrollable nature of both public spaces and social robots can become an emotional and social opportunity rather than a threat.

5.3 Solutionism Inscribed? A Critical Reflection on the Method

Our adaptation of Techno-Mimesis [37] incorporates not only stakeholder perspectives but also the perspective of the robot itself. This enabled rapid prototyping of scenarios involving technologies that do not yet exist. Taking on the robot's point of view – temporarily becoming the robot – gave participants an embodied understanding of its capabilities (e.g., what moving on wheels affords) and an experiential sense of how their actions might affect a social situation (e.g., why a gesture feels intrusive and how the robot could adjust its behavior). Previous Techno-Mimesis work has shown that *technomorphizing* the human body can prompt participants to question anthropomorphic assumptions about robots. The dual perspective – switching between human and robot – enabled participants to compare both roles directly and to recognize what each can uniquely do. [37]. We observed a similar effect: embodying the robot helped adolescents articulate why robots could – and in some cases should – be different from humans.

While previous implementations of Techno-Mimesis worked with roboticists to elicit insights into already existing robot concepts, our method invites lay adolescents to ideate and co-develop new robots from scratch. This aligns with increasing calls for co-creation in public robot design [33, 53, 89, 129], which emphasize the need to involve non-experts and directly affected communities.

However, such a shift comes with new challenges and opportunities. Unlike roboticists, adolescents cannot draw on deeper technical knowledge of sensor-actuator setups. Instead, their ideas are shaped by personal experience with existing robot-like devices, such as chatbots or popular imaginaries of robots from works of science fiction. None of the participants had prior hands-on experience with real robots. As a result, their enactments may reflect unrealistic or outdated assumptions – and it is probably more difficult for them than for roboticists to stay in the robotic role without reverting to human emotions and interactions. Thus, as a matter of course, our findings provide insight not into real human-human-robot interaction, but into human projections and imaginaries of dreaded or desired robotic social roles.

Yet, this lack of expertise also proved generative. Experienced roboticists often remain constrained by what they know to be technically feasible, which can limit the exploration of new social scenarios. In contrast, adolescents' fantastical assumptions opened speculative space for imagining what robots could become – beyond current capabilities. Notably, despite varied theater experience, we observed no consistent differences in engagement or openness during enactment – this may be due to the support that we provided, such as the acting warm-ups.

Like other speculative design methods [35, 41, 42], our approach reveals participants' hopes, concerns, and relational desires – not necessarily how interaction with actual robots would unfold in practice. These insights, however, can inform the design of real future robots that are more attuned to human values.

The emphasis on ideation carries the risk of falling into solutionist traps – a tendency to design technological fixes for complex social issues without sufficiently interrogating the underlying problems [90]. As mentioned in our findings, adolescents often embraced their concepts with great enthusiasm, sometimes leading to final enactments resembling promotional scenarios in which robots resolved social situations with happy endings. Former frictions were smoothed over. Beyond, a participant remarked on overengineering (see 4.4: *"Why did we make it so high-tech?"*). Such moments of doubt underscore a broader issue: whether we, together with the participants, imagined overly elaborate robots for relatively mundane challenges or offered simplistic answers to complex social frictions.

Despite our intention to frame the artefacts as open-ended design research objects [131], the setup itself may have implicitly promoted robotic solutions. Through prompt cards and leading questions (e.g., "How could a robot help…?"), we arguably presupposed the desirability of robotic intervention – echoing James Auger's provocation that "the robot is too often a solution in search of a problem" [3].

Nevertheless, since we experienced conflicts to be most insightful during the improvisational sessions, we did not treat frictions as failures that required solving. When conflicts emerged in a scene, we sometimes replayed it with small variations (e.g., swapping roles or changing a single capability of the robot) and invited participants to articulate how and why the interaction felt different to them.

Beyond that, we argue that focusing on robotic street furniture – rather than general-purpose robots – was a productive design constraint. Grounding the imaginary in everyday objects such as benches, bins, or traffic lights allowed us (1) to anchor the speculative scenarios in adolescents' lived experiences, and (2) to avoid anthropomorphic clichés by designing robots that do not mimic humans but offer alternative modes of social presence.

In doing so, we were able to move beyond dystopian or utopian sci-fi narratives and instead explore novel, meaningful modes of

coexistence with robots [39]. This aligns with current efforts to "automate the infrastructure that is already embedded" in public space [17] and with emerging design paradigms such as Objects with Intent [104] and hybrid robotic forms [83], which aim to challenge stereotypical expectations about robots' appearance and behavior.

5.4 Limitations and Future Work

While our study provides rich insights into how adolescents envision social robotic furniture in public spaces, several limitations shape our work's scope and point toward productive directions for future research.

First, the study captures a snapshot of adolescents' imaginaries within a time-limited workshop setting. Although the enactments simulated public dynamics, they were not conducted in real public environments or over extended timeframes. Future longitudinal, in-situ interventions could explore how perceptions, behaviors, and meanings around robotic furniture evolve as they become embedded in local routines and everyday frictions.

Second, our participant group was intentionally focused on adolescents from an urban context. This allowed us to explore a group whose wishes for technology design and specific social needs in public space are often overlooked. However, public space is inherently shared, and robotic street furniture would also be used by adults. We expect that adult participants would foreground different concerns – for example, placing more emphasis on safety, comfort, and efficiency, imagining fewer intergenerational storylines, and showing less interest in practices such as complimenting each other, which for adolescents might be closely tied to identity formation and peer-related self-esteem. However, we cannot know this without actually conducting a comparable study. Therefore, future research could either focus on adults alone or include both adolescents and adults to explore how their perspectives relate to one another, and how robotic interventions might mediate between generations.

Third, to avoid solutionist pitfalls, future co-design processes could allow more time for critical engagement, explicitly invite participants to take opposing or skeptical roles, and analyze reasons for concept rejection or failure. In addition, second-order engagements – where new participants from different cultural or demographic backgrounds critique or re-enact previously developed concepts – could elicit more distanced, possibly more critical, perspectives. Future work could also involve participants more directly in developing the analysis template and design suggestions; in our study, adolescents evaluated their own concepts through reflection phases, video-taped first-person reflections, and the robot profiles, but the final analytic framing was produced by the research team. Drawing on methods such as ironic design or exaggeration [9, 10] may further support reflection on the limitations and implications of technological interventions.

Fourth, while we describe adolescents as a marginalized group, our theater-based approach did not explicitly draw on traditions such as Theatre of the Oppressed [12] or critical pedagogy [45]. Power and positionality were addressed indirectly – for instance, through reflective questions about who might be excluded, harmed, or privileged in a given scenario – but were not systematically foregrounded as an organizing principle of the workshops. Future work could build on our enactment-based method while adopting more explicitly critical and socially engaged theater practices (e.g., Forum Theatre), co-facilitation with youth, or design justice frameworks [28] to more directly address power imbalances and marginalization.

Finally, our decision to start with existing urban furniture helped ground speculation in everyday experience and avoid sci-fi stereotypes. However, many final concepts ultimately diverged from the original social scripts of these street objects. For instance, traffic lights became whimsical mediators rather than rule enforcers. While some practices (e.g., waiting or observing) were preserved, others – such as ignoring the lights in playful disobedience – were overlooked. Future research could examine such scripts more closely and consider how robotic extensions might build on or subvert them more deliberately.

6 Conclusion

This paper explored how robotic street furniture might support adolescent social interaction in public spaces. Through a theater-based co-design process, we created 10 speculative robot concepts that reimagined benches, traffic lights, bike racks, and other street furniture as social enablers. Rather than replacing human contact, these robots supported social encounter, reflection, and communication – drawing on their own non-human strengths. From these enactments, we derived eight design suggestions grounded in identified robotic roles, strengths, and weaknesses.

These suggestions – such as nonverbal communication, orchestrated "coincidences", or intentional imperfection – offer concrete starting points for designers seeking to create socially attuned robots that facilitate and mediate human connection rather than supplant it.

By foregrounding adolescent perspectives, we highlight the potential of robots not only to facilitate social contact, but to support the development of social capacities – such as empathy, self-efficacy, and respectful engagement with difference. At the same time, our study calls for caution: robotic mediation should strengthen adolescents' ability to connect on their own. Designing for public space poses particular challenges, as its social dynamics are fluid, highly context-dependent, and often difficult to anticipate. Even small shifts in robotic behavior or placement can lead to unintended social consequences. Future research should therefore examine how such systems can inhabit public space in socially responsive ways – without dominating or displacing human interaction.

Our findings also highlight a key paradox: while robots can support meaningful social moments, these are often difficult to engineer deliberately. Just like known examples of robots with human-human social effect in public (e.g., *Hitchbot*), our codesigned robots became meaningful not because they explicitly aimed to foster connection, but because they allowed for unplanned, open-ended interactions. In contrast, attempts to "design" sociality can seem intrusive or inauthentic, especially in complex, dynamic settings like public spaces. This underscores the importance of designing for subtle affordances rather than scripted outcomes and treating robotic "superpowers" as context-dependent resources rather than universal solutions.

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Appendix

Table A.1: Identified themes, addressed psychological needs by Hassenzahl et al. and prompt questions derived for the enactment phase

Adolescents want...	**Needs**	**Prompt Questions**
to be brave, push themself, and grow beyond their limits	Competence	How could a robot encourage people to overcome their inhibitions and engage with others?
to feel proud of accomplishing something together	Competence, Relatedness	How could a robot encourage people to become accomplices?
to be a role model for others	Popularity	How could a robot turn one person into a role model for others?
to receive appreciation and recognition	Popularity, Relatedness	How could a robot provoke people to give each other compliments?
to radiate trust and be perceived as trustworthy	Popularity, Relatedness	
to receive a compliment and feel happy about it	Popularity, Relatedness	
to help others and offer support	Popularity, Relatedness	How could a robot motivate someone to help another person?
to be asked for help	Popularity, Relatedness	
to receive help oneself and experience gratitude	Relatedness	
to discover unexpected commonalities with others	Stimulation, Relatedness	How could a robot help people discover or create commonalities?
to be inspired by others	Stimulation	How could a robot make people change perspective?
to give a compliment and bring joy to someone	Autonomy, Relatedness	How could a robot make people feel they have a positive impact on others?
to make a positive impact and a meaningful difference	Autonomy	
Adolescents do not want...		
to be misunderstood	Competence, Relatedness	How could a robot help uncover misunderstandings between people?
to be ignored	Popularity, Relatedness	How could a robot encourage people to reconsider their prejudices?
to behave inappropriately by accident	Popularity	How could a robot encourage people to reflect on hurtful, intrusive, or inappropriate behavior?
to feel helpless	Competence, Autonomy	How could a robot help people avoid unproductive conflicts?
to be pressured or harassed	Security	How could a robot help people recognize and respect personal boundaries?
		How could a robot encourage people not to be unsettled by others' judgments (looks, comments, catcalling)?

Table A.2: Participants worked with 8 of the 10 sets (prompt with bench was used for several sessions) which resulted in 10 robot concepts.

Prompt Question	Type of Robot	Characteristics	Props
How could a robot encourage people to overcome their inhibitions and engage with others?	Autonomous park bench	Recognizes people Recognizes touch Haptic output Ability to move	Glasses, touch-sensitive blankets, vibration massager, roller board
How could a robot encourage people to become accomplices?	Autonomous bike stand	Recognizes touch Voice output Sound output	Sleeping mask, touch button, karaoke microphone, bike lock, suit, bike
How could a robot turn one person into a role model for others?	Autonomous bin	Recognizes people Recognizes surroundings Voice output	Basket with detection sensor, ear protection, karaoke microphone, plastic tunnel
How could a robot provoke people to give each other compliments?	Autonomous bollard	Sound output Visual output Vertical mobiliy	Glasses, stick-on eyes, play tunnel, stick-on note as display
How could a robot motivate someone to help another person?	Autonomous sidewalk	Recognizes people Recognizes sound Recognizes touch Visual output Ability to grasp	Glasses, directed hearing, arm/ gloves/ grabber, strings, display
How could a robot help people discover or create commonalities?	Autonomous guide	Recognizes people Recognizes sound Visual output Ability to gasp	Glasses, directed hearing, arm/gloves, signs/ display board, suit
How could a robot make people change perspective?	Autonomous seating blocks	Recognizes touch Voice output Sound output Visual output	Sleeping mask, touch-sensitive blanket, karaoke microphone, colorful string lights with color-changing lights, flashlight(s), suit
How could a robot encourage people to reconsider their prejudices?	Autonomous traffic lights	Recognizes people Voice output Haptic output Visual output	Face recognition glasses, karaoke microphone, different colored pieces of paper/ post-its, RGB-colored push button, suit
How could a robot encourage people to reflect on hurtful, intrusive, or inappropriate behavior?	Autonomous street lamp	Recognizes people Recognizes sound Voice output Sound output Visual output Ability to grasp	Directed hearing, horn(s), movable light sources, flashlight, gloves
How could a robot help people avoid unproductive conflicts?	Autonomous wall	Recognizes people Recognizes sounds Voice output Ability to move	Emotion glasses, green poncho, ivy wall, rope

Table A.3: Full description of the 10 concepts

Title	Description
Pushy Bench: Intrusive Matchmaking	The Pushy Bench is mobile and equipped with emotion recognition. It moves lonely, sad individuals sitting on it toward other people who are also sitting on benches, encouraging them to connect. The bench vibrates as a prompt to start a conversation.
Roaming Benches: Invitation to Serendipity	The Roaming Benches are a system of benches that move freely through the urban space. They invite people to explore the city, observe their surroundings, and let their thoughts wander. These benches create "planned coincidences" by moving in a way that causes people to encounter each other repeatedly – sometimes closer, sometimes farther away, sometimes for longer, sometimes just briefly. For those sitting on the benches, these encounters create the feeling of a curious and unexpected coincidence. However, the benches use their emotion recognition to anticipate which "coincidences" might make sense and which might not – so they plan accordingly.
Enlightning Bench: A Beacon of Help	The Enlightening Bench invites people to sit while quietly sensing their emotional state. It raises public awareness by detecting signs of distress and lighting up to signal that someone might need help. Using pulse and stress detection, the bench identifies individuals who may be struggling – while also interpreting cues related to honesty and intent. Rather than enforcing action, it gently encourages empathy and attentiveness in public spaces. Passersby can choose to respond to the signal and offer support, creating opportunities for spontaneous connection and mutual care.
Talking Traffic Lights: Therapy for Prejudiced Signals	Talking Traffic Lights are a system of anthropomorphized robots. Usually, two of them are posed opposite each other. They can talk to the pedestrians waiting at them with human speech. But the traffic lights cannot communicate directly with each other. The traffic lights have different biases, misunderstandings, antipathies, and sympathies toward each other. They use the pedestrians as carriers to deliver messages to the other traffic light, such as the expression of a strong dislike for another traffic light. The pedestrians are faced with the challenge of dealing with this contrasting relationship between the traffic lights.
Intervening Wall: Space for Resolution	The Intervening Wall can move, change its size, and output sound/light signals. It cannot express human speech, but it recognizes conflict situations and can evaluate them. If the autonomous wall detects a conflict situation that threatens to escalate, it can move between the people, change its size to block the interaction, and intervene through the light/sound effects. If the situation cools down, the wall gets smaller and silent, letting the people talk again.
Reflective Seating Blocks: Seeing through Others' Eyes	The Reflective Seating Blocks are a system of stationary seats that can hear their surroundings but cannot see them. They communicate with people sitting on them using speech and can also exchange information with one another. Since they are "blind" themselves, they usually start a conversation by asking for a description and evaluation of the environment (e.g. "What do you see around you?", "Do the people you see look happy?") and go on with more private conversations (e.g. "Why do you dislike people that look that way?). Everything they know about the world comes from the diverse individual perspectives of those who sit on them. They not only gather insights but also confront people with the viewpoints, advice, and opinions of others (e.g. "I've heard, there are a lot of people around that seem to be stressed"). Additionally, they actively seek guidance and assistance from individuals to pass on helpful messages to others.
Playful Bin: An Echo to Cheer on	The Playful Bin encourages responsible waste disposal through light, sound, and behavior feedback. It scans deposited items to check whether they are indeed waste and if they were disposed of correctly. When waste is properly thrown in, it rewards the action with a green light and a cheerful sound. If the item misses the bin, it responds with a red light and a disapproving sound. The bin can also eject incorrectly sorted items, prompting users to try again. A spotlight highlights moments of incorrect disposal, gently drawing attention to the mistake without shaming individuals. This often inspires bystanders to help each other, making the bin a playful catalyst for social cooperation and environmental awareness.

Assistive Bike Stands: Human-Robot Network of Help	Assistive Bike Stands are a system distributed around the city. They have a button that can be used to activate them and ask them questions with voice input and output. The bike stands cannot see and only become active when you press their button. The stations offer various services: They help form cycling groups for those who prefer not to ride alone (e.g., on a late-night journey home). They connect people with bike issues to others who can assist with repairs. They provide rental bikes and facilitate specialized interest groups (e.g., a "raincoat group") for shared outings. The bike stands can communicate with each other so that they know what is happening at the other bike stands. This allows them to navigate questioners to other bike stands where they can meet other cyclists with similar interests or can get help.
Complimenting Bollard: Filtered Flattery	Complimenting Bollards anonymously transmit compliments between people. Users can instruct the bollard to deliver a compliment to another person nearby. The bollard, which can move through space and communicates its function via a display but uses speech for human interaction, then approaches the intended recipient. This person is given the option to accept or decline the unknown compliment. If accepted, the bollard delivers the compliment in its own words, always modifying it slightly. Whenever only one person in a group is meant to receive a compliment, the robot invents additional compliments for the others to ensure no one feels left out. Compliments that constitute inappropriate advances or offensive remarks are not transmitted. Instead, the robot clearly signals to the sender that such statements are unacceptable.
Destiny Signpost: Bridging Paths Together	Destiny Signposts are distributed throughout the city to create unexpected, spontaneous social interactions and exploration of the environment. Each signpost detects when a person is standing in front of it and activates its screen if another person is present at a different signpost simultaneously. People can initiate a game, similar to geocashing, where they can see each other's locations on the display. The signpost then provides directional guidance, but with intentional deviations.

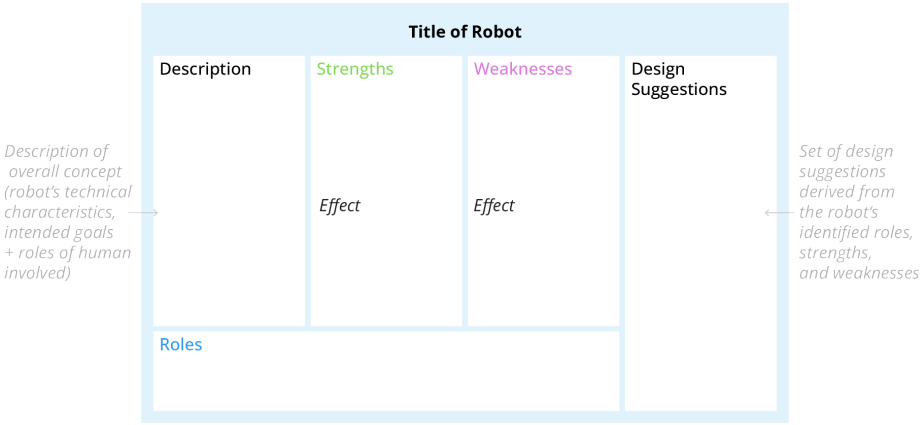


Figure A.1: Template used to merge the analysis for each robot concept (consisting of the videos and completed robot profiles). We consolidated the identified social strengths, weaknesses, and roles into several design suggestions for each robot.