The Telerobot Contact Hypothesis⋆

Avner Peled[1][0000−0002−0525−6385], Teemu Leinonen[1][0000−0002−6227−052X], and
Béatrice Hasler[2][0000−0002−3251−4677]

[1] Department of Media, Aalto University, Espoo, Finland
avner.peled@aalto.fi
teemu.leinonen@aalto.fi
[2] Sammy Ofer School of Communications, Interdisciplinary Center Herzliya, Herzliya,
Israel
hbeatrice@idc.ac.il

Abstract. We propose the use of telepresence robots as a medium for
intergroup contact that aims at reducing prejudice between groups in
conflict. We argue for robots as a midpoint between online communication
and a face-to-face meeting, combining the flexibility of the virtual world
and the depth of physical interactions. We define the basic architecture
of telepresence systems and present a conceptual framework for robot-
mediated encounters in an intergroup context. We then provide design
guidelines for telepresence systems that may guide future implementations
of robotic intergroup contact.

Keywords: Intergroup Contact · Human-Robot Interaction · Telep-
resence Conflict Resolution

Table of Contents

1   Introduction

In evaluating the current state of human rights and ecological sustainability, the bright future promised by globalization and technological advancement has, so far, underperformed. On the one hand, an exponentially growing realization of the earth's finite resources [77] meets the human race's seemingly inept ability to navigate the market to morally favorable prospects [132]. On the other hand, the prospect of a globally connected society has done little to alleviate hate, prejudice, and conflict between conflicting groups and nations. In some cases, the internet has even become a petri dish for disseminating prejudice and violence [36, 61, 115, 127]. At the same time, we are dealing with the global COVID-19 pandemic, which provided a blatant reminder of both the perils and importance of physical closeness, and our reliance on technology to bridge over physical gaps.

This research investigates how communication technology could provide a more grounded and physical experience when face-to-face encounters are not possible. Particularly, we look for technology as a means for reconciliation and peacebuilding between groups in conflict that are plagued by a history of prejudice and racialized narratives. Building on the proven principles of the *intergroup contact*

hypothesis, outlined by Gordon Allport in the 1954 seminal work *The Nature of Prejudice* [**(year?)**], we explore *telerobotics* (remotely operated robots) as a new medium that has the potential to facilitate positive intergroup contact. We hypothesize that if designed equally, openly, and with cultural sensitivity, the physical presence of robots as a communication tool could address a certain corporeal lack in virtual mediums of online contact. Telerobots could maintain the openness and accessibility of virtual spaces such as VR and Social Networking Services, but alleviate dissociations and confusions enacted by the dismissal of the body [25, 107, 128]. A more grounded interaction could also counteract tendencies for abstraction and reification of the other [1, 40, 112] and to engage with the corporeality of identity [54]. Finally, by bringing online communication *Down to Earth* [78] we make sure to not forget the importance of the environment that supports it.

We have previously established the potentialities of telerobot-based contact and suggested basic guidelines and possible pitfalls [99]. In this article, we expound on this notion with a more comprehensive literature review and expand or conceptual model for full *telerobot contact hypothesis.*

2   Taxonomy: telepresence, telerobots, and avatars

Telerobots are often referred to as *telepresence robots.* Originally, the term *telepresence* was used by Marvin Minsky and Patrick Gunkel to describe a vision of a futuristic economy in which people perform manual, physical labor from remote locations [87]. While *teleoperation* describes the broad action of remotely operating a robot, telepresence refers to the immersive experience of being in a remote environment, mediated by a physical sensing agent, that is, a *telerobot*[26, 64, 110]. In phenomenology the term *re-embodiment* is also used to describe the experience of telepresence [37]. Today's telerobots go beyond industrial use and are deployed in social care [86], education [119], and interpersonal communication [95], utilizing the internet as the medium for teleoperation.

When describing a telerobot serves as a remote representation of a human operator, it is often referred to as its *avatar.* The human operator could then be referred to as the *inhabiter* of that avatar. An avatar is an antonym for *agent*, a computer-controlled entity that acts autonomously without any human intervention. A telerobot is usually, however, *semi-autonomous*; its actions are predominantly decided by the human operator, but supported by machine-controlled algorithms. A semi-autonomous telerobot is sometimes referred to as *surrogate* [57, 90], a combination of agent and avatar. While intergroup contact may as well take place against, or supported by, a fully simulated agent [47, 52, 63, 106, 109], here we focus our attention on scenarios in which at least one of the group members is represented by a robotic avatar, which was shown to increase social influence [38].

3   Conceptual model

Previous research on intergroup contact provides us with conceptual and computational tools that we can use to model the path from initial contact to the eventual reduction of prejudice toward the outgroup. The model suggested by Pettigrew [101] outlines a longitudinal process of prejudice reduction: the ingroup member initially *decategorizes* the outgroup member from its group, then reduces prejudice from the general outgroup, and finally dissolves the border between ingroup and outgroup. Researchers have also formulated empirical models that predict and verify the link between common mediators such as anxiety and empathy, or moderators such as group salience to the outcome of the contact [23, 96, 123].

Based on these examples, we suggest a path model for telerobot-based contact (see fig. 1) which includes the stages of projecting the telerobot interaction to the interpersonal and then projecting the interpersonal to the intergroup. The path depends on the type of experience - interaction with a telerobot or operation of a telerobot. In the case of interaction, we hypothesize the attitude toward the outgroup member will be moderated by the degree of perceived *co-presence*. Initially formulated by Goffman as a measure of our awareness of another human being in our physical space [42], the term is now used in similar fashion for virtual [17, 28, 113], and physical [30, 58] environments. Co-presence was found to mediate positive attitude and intimacy in social networks [2].

When operating a telerobot we are looking for a close and long-lasting social link between the operator and its robotic avatar. Several models are used in the literature to describe these phenomenon, including: Belk's *extended self* [16], the *proteus effect* [130], *parasociality* [60], and *self-presence* [14]. Self-presence entails engagement and a lasting social effect and was shown to mediate intergroup friendship, we therefore chose it as a moderator. However, it was not found to be a sufficient moderator for improving the broad attitude toward the outgroup [6, 15].

Indeed, the final stage of outgroup generalization and reduction of prejudice proves to be the most elusive. Most factors have received mixed results in online and VR contact, but significant evidence suggests that outgroup group salience (the presence of cues suggesting the outgroup member's group affiliation) is important [23, 68, 123]. However, in the case of ingroup identity salience, the effect is not clear, commonly intertwined with other variables[6, 100] and in some cases achieving the opposite effect [5].

The following sections present our hypotheses for telerobot contact. We look into questions of robot design, interaction modalities and peacebuilding scenarios.
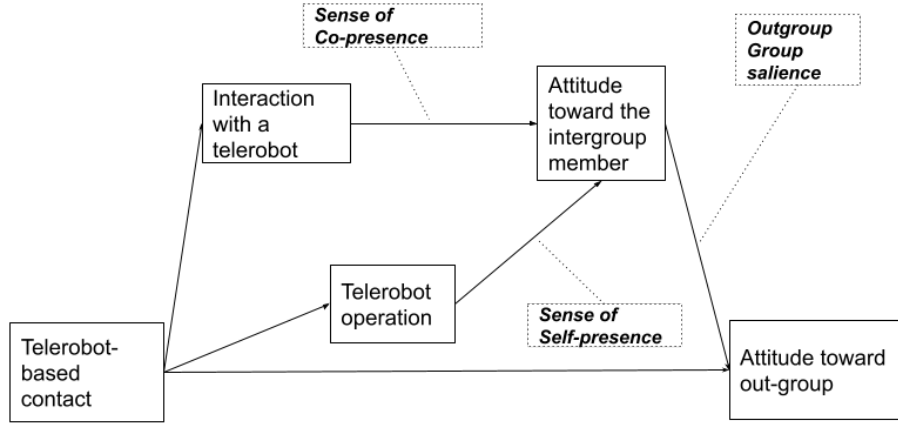
Figure 1: Telepresence Contact: Conceptual model

4 Telerobot contact hypotheses

4.1 System architecture

A communication event that is mediated by telerobots could manifest in one of three different architectures that we identified as *telerobot systems*: asymmetric, symmetric bidirectional, and symmetric unidirectional [99]. Fig. 2 illustrates the three types Utilizing concepts from Paynter's generalized systems theory [46, 97], we describe two types of interactions: *signal*, and *physical*. *Physical* refers to real word interactions between elements sharing a physical environment, such as a hand-shake or holding an object. *Signal* interactions occur on an abstract level. They represent a unidirectional logical flow of cause and effect; for example, text that is typed on one end of online communication and appears on the other end.

Although the *symmetric unidirectional* system has its own merits, in our hypothesis we assume that that at least one participant is physically interacting with a robot, therefore we focus on the first two systems.

One of Allport's conditions for positive intergroup contact is having an equal status between group members, for example, colleagues in a workplace context [3]. It was shown that having symmetry and equality in communication is beneficial for contact in groups that are in asymmetric conflicts, such as the Israeli-Palestinian conflict [83].

Symmetric telepresence systems provide the hardware foundation for equality in contact situations as both participants face the same conditions. Asymmetric systems, however, produce an experience that is different in nature for both sides. The side that is operating the telerobot from a remote control interface is more aware of the interaction medium and may feel concealed behind it. Consequently,
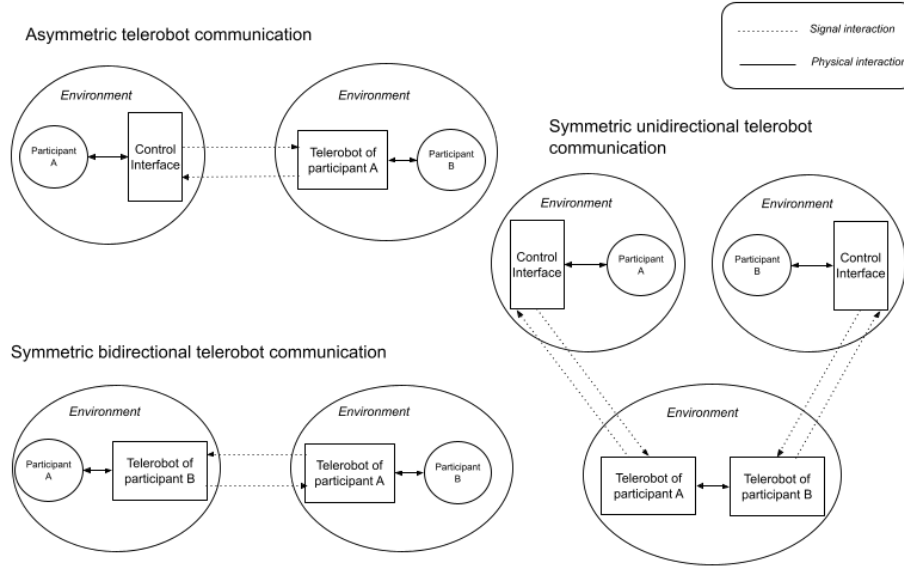
Figure 2: Systems of telepresence communication

they may exhibit behaviors that characterize anonymous computer-mediated-communication (CMC). Research models have shown a varying effect of CMC on the outcome of intergroup contact and the reduction of prejudice [126]. The *deindividuation* model warns that anonymity may release a person from social regulation and norms, leading to a negative effect on the conversation. SIDE theory [114] provides a contrasting view in which a depersonalized encounter increases group salience, as it motivates individuals to act under a group context while pronouncing enhanced norms and tropes. Models such as SIP (social information theory) and *hyperpersonal* communication [125] advocate that more intimate interpersonal relations may form in online contact because of the need for the participants to make up for the lack of non-verbal cues.

The side that is interacting with the robot, however, is less aware of mediation that is taking place and may experience strong senses of *agency* (I am the initiator of an act) and *ownership* (my body is that is moving) in the interaction with the robot [32, 39]. Therefore, behaviors may resemble more that of a direct encounter than online contact. CMC-related effects may still occur, corresponding with the level of co-presence. When the robot is perceived more like a medium rather than an avatar, the interlocutors would be more conscientious of their ability to manipulate their identity and presence.

This asymmetry in the participants' perception of the medium could be beneficial. In one use-case between advantaged and disadvantaged groups, a disadvantaged-group member may operate a telerobot remotely from their home, while the advantaged-group member is interacting with it in a public space. This scenario

is likely to reduce anxiety as the operator remains in their comfort zone and may get empowered by the ability to see through the robot's camera while not being seen by the interaction partner. That may not only lower the participation threshold in an intergroup contact project but may also encourage bringing up more difficult topics related to conflict during the conversation. However, such a reversed power asymmetry in robotic intergroup encounters could also disrupt the experience. In an initial test case conducted in an intercultural setting between minority and majority groups in Finland, participants felt uncomfortable with the asymmetry. One member of a minority group noted that they felt as if they were a government official investigating their exposed partners [98, p.132].

To summarize, asymmetric telepresence systems may have some benefits associated with CMC, but may also induce a sense of inequality in communication. Symmetric systems provide the foundation for equal grounds, leaving it up to further design choices to maintain this balance. In the following section, we turn to design factors that are likely to influence the process and outcome of robotic telepresence contact in an intergroup context.

4.2   Visual appearance

The effect of a robot's appearance on a human's attitude toward it has been studied extensively in the literature, predominantly in studies of Human-Robot Interaction (HRI) and social robotics [45].

tbl. 1 provides a summary of the above factors that correlate with anthropomorphism. We hypothesize that negative effects may be balanced or mitigated by adding external cues and explanations. For example, we could place visual cues that remind the interlocutor of the human inhabiting the avatar. We expand more on this in the section regarding group salience. Appearance choice should always be context-dependent and culturally sensitive to the situation at hand. As a general rule, a softer (discussed in the section on materiality), non-threatening, and equal appearance (for example, equal height, as noted by Lee et al.[**(year?)**]) is favorable for intergroup contact.

Table 1: Anthropomorphism: summary table.

Level of anthropomorphism	Risk of the uncanny valley	Risk of dehumanization	Operator's sense of self-extension	Interlocutor's sense of co-presence
Low	Low	High	High	Low
High	High	Low	Low	High

4.3   Use of an embedded display

The telepresence robot market is rapidly growing, and is predicted to accelerate even more in the upcoming years due to increased demand for advanced tech-

nological solutions to support remote working and social services.[3] Telerobot forms are continuously branching into new directions, but the dominant form remains that of a tablet device attached to a motor vehicle [74] (See fig. 3). The tablet typically displays the operator's head, as in a video call. Examples from market leaders include *Double Robotics*,[4] *Mantaro*[5] and Revolve Robotics.[6] Such telepresence robots are geared toward remote offices and public service environments, such as hospitals or schools.

Figure 3: The *Double Robotics* Double 3 telerobot

The question of using a simulated face display on a robot, vis-à-vis an embodied, mechatronic face, has been troubling the HRI community since the early days of personal service robots [120]. Recently, the sense of inconsistency felt when interacting with a 2D display on a telepresence robot was verbalized by Choi and Kwak as the *dual ecologies problem* [29]. In their study, the perceived presence of a user in a tablet-based video call was higher when it was disembodied (tablet only) than when the tablet was attached to a wheeled robotic body. The authors explain this by referring to the different ecologies present in the same robot; One is a 2D projection of the remote location, and another is the physical presence of the robotic body in a shared space. They suggest that the receiver of communication experiences confusion, having to interact simultaneously with the immediate environment, and with the depiction of the remote environment.

Our initial test showed similar results: the use of a display on the body of the telerobot was disruptive to the participants' perceived sense of co-presence.

---

[3] https://www.marketwatch.com/press-release/telepresence-robots-market-size-2020-to-showing-impressive-growth-by-2024-industry-trends-share-size-top-key-players-analysis-and-forecast-research-2020-04-20

[4] https://www.doublerobotics.com/

[5] http://www.mantarobot.com/products/teleme-2/index.htm

[6] https://telepresencerobots.com/robots/kubi

Participants reported reverting to the experience of using a phone-like device while they were interacting with the display, despite having to touch the robot to initiate actions in the virtual interface [98, p.127].

Back projection solutions such as those of *Furhat Robotics*[7] attempt to solve this incongruence by projecting 3d-mapped virtual information directly onto the robot's surface. While this may moderate the negative effects of the display, it does not entirely address the dual ecologies problem of having two different spatial sources combined into one. We, therefore, recommend the use of a display to be planned carefully for intergroup contact. Preferably, the appearance of the robot could be designed without an external display, maintaining uniformity and consistency.

4.4   Voice

In a telepresence robot-based contact, an operator may choose to use their voice or a synthetic voice that does not disclose their personality, gender, and culture. They may also use a synthetically cloned voice that is highly similar to their natural voice [59]. A synthetic voice adds modalities for speech augmentation and language translation, as we discuss in the section regarding interaction modalities.

Research about the effect of an avatar's voice on user attitude shows that as with visual appearance, one must strike a balance between relatedness and consistency. Lee and Nass studied the sense of social presence of e-commerce agents with machine-generated voices [80] concerning their personality (introvert or extrovert). When the voice personality of an agent is closer to that of the interlocutor, the perceived sense of social presence increased. However, the consistency of the voice with its personality is essential. Social presence drops if a voice's style is incongruent with its textual character. Another study by Mitchel et al. [88] found that a mismatch between the voice and face of a talking head generated an uncanny sensation. A human with a synthetic voice felt as uncanny as a robot with a human voice. Therefore, an optimal voice would be one that takes the telepresent human into account, without diverging abruptly the physical form of the avatar.

4.5   Materiality

The choice of materials has considerable implications for robot design. In industrial robots, materials are chosen *functionally*, following the task at hand. In robots designated for human interaction, rather than materials, we examine *materiality*. Conceptualized by Hayle, materiality is "physical qualities that present themselves to us" [49, p.72]. Materiality is exhibited through two main aspects of a robot's constitution: 1) The outer skin: the part of the robot that touches and is touched, and 2) Actuation: the material that actuates, generating the robot's movements. With the former, we place materials on a scale of firmness and rigidness; how

---

[7] https://furhatrobotics.com/

soft they feel to the touch. With the latter, we define materials on a scale of flexibility and linearity that describes the nature of the material's movement.

Previous research in social robotics supports the use of soft materials for the outer skin of robots, especially in interaction with children [72] and in elderly care [21, 70]. Soft materials contribute to a sense of *affective touch* between the robot and humans [69, 117]. The human body and other natural forms are inherently soft, favoring co-existence with other soft materials [34]. However, carrying an object closer to the realm of the living risks invoking an uncanny feeling as with an anthropomorphic appearance. For example, touching a smooth, soft, material that is also cold evokes the uncanny [92, 129].

A soft touch on the surface doesn't necessarily imply a softness as a whole. For example, a gripping robotic hand made from powerful servo motors wrapped in a soft skin could still easily, and inadvertently, crush soft tissue. *Soft Robotics* is a rapidly developing research field for robots that operate on soft materials down the level of actuation [13]. Commonly used materials are fabrics and silicone rubbers, while the most typical form of actuation is pneumatic: applying air pressure or vacuum. Presently, the largest consumers of soft robotics are the medical industry, utilizing the soft materials for invasive and surgical procedures. The use of soft robots for human interaction is nonetheless actively researched and has so far exhibited positive results [19, 62, 124]. In our test of soft robotic telepresence, we have reached similarly promising conclusions [98].

Designers using soft robotics for interaction should take special note to some idiosyncratic features of soft actuators. Due to the highly organic style of soft-robotic actuation, the risk of falling into the uncanny valley is increasing as the robot moves like a living creature. Additionally, pneumatic soft robots are often tethered (connected by a cable), which restricts their ability to move around the space [104]. Nevertheless, a soft approach deems viable for telepresence contact. Soft movement and touch may increase empathy and intimacy between the participants, resulting in a more positive evaluation of the group they represent. Softness also instills a notion of safety; an inability to cause harm. That is a desirable climate in situations of intergroup conflict.

4.6   Physical props

When participants are aware of their interaction partner's group membership and if the interaction partner is regarded as a (typical) representative of his or her group, positive effects of the interpersonal encounter are more likely to generalize to the outgroup as a whole. One approach, suggested by Pettigrew [101], is to expose group identities gradually, starting with a low salience, allowing initial contact to form, and increasing it over time as the interaction partners establish an interpersonal relationship.

Group identity can be transmitted through a variety of channels in robotic telepresence, beginning with the design of the avatar; its appearance, voice, and its surroundings, and proceeding into the content of the interaction. A robotic

avatar may have a non-humanoid appearance, but still maintain group identity through group symbols, cues, and language. It may speak in a group-specific language or accent, wear typical accessories or flaunt national colors. The freedom to use material objects brings up new design possibilities that are not available in an online encounter. Group cues may be positioned in subtle ways to be gradually revealed by the interlocutor. If the initial appearance and behavior of the robot are engaging enough, an interpersonal bond may form despite the presence of group-related cues.

4.7   AI

The outstanding benefit of mediated verbal interaction for intergroup contact is the ability to translate between different languages and dialects [7]. Often groups in conflict do not speak a common language and are required to speak in a third language in the language of the advantaged/majority group. This situation forms an obstacle to achieving equality in contact. Language translation may reinforce equality in communication, as all participants can express themselves in their native language. Machine translation, however, may also be destructive to cultural and political nuances [33, 81], and contemporary deep-learning translators exhibit stylistic and gender bias based on their training datasets [56, 116]. Models such as Timo Honkella's "peace machine" [53, 71] attempt to resolve this problem by preserving cultural-dependent meanings within a translation.

While no data exist on the implications of machine translation in intergroup contact, human translators and interpreters often suffer from a lack of trust by the participants who fear of bias and misinterpretation [89]; a machine translator may enfold similar risks. In our initial test for automatic language translation in contact between minority and majority groups in Finland, participants enjoyed their newly acquired ability to speak to one another in their language, but have raised concerns about being misrepresented by the machine [98]. Further research should focus on implementing and evaluating feedback mechanisms within the translation process that may reduce the fear of misinterpretation.

5   Interaction modalities

In this section we explore possible affordances [41, p.285] in telerobot design, and theorize over different modalities [73], modes for interaction, that may assist in intergroup contact, and consider implementation detail.

5.1   Movement in space

The ability to move a body in space distinguishes robots from other interactive technologies. However, not all robots have the same degrees of freedom and granularity when it comes to movement. In the field of social robots, *mobile robots* typically travel around using wheeled motion. Examples include service robots,

such as Pepper[8] and Samsung bots[9], and telepresence robots such as Double Robotics[10] and Beam[11]. Other robots only move their body while remaining stationary in place; for example, care robots such as PARO,[12] and telepresence robots from Ishiguru laboratories.[13] Due to the complexity of maintaining both modalities in interaction, mobile robots often keep a physical distance from the user, interacting using voice and visuals they travel around the space. Stationary robots, on the other hand, tend to rely more on haptic interaction, allowing the user to hold and touch them. Only a few robots attempt to combine both modalities, such as Teo [20].

Touch-based human-robot interactions have an affective value [8, 69] that may benefit intergroup contact and should hold a high priority in the design process. Furthermore, in the case of symmetric telepresence, moving around is in itself limited since the operator does not have a dedicated control interface for traveling, and movement relies only on body tracking. In asymmetric systems, camera navigation is possible but may still divert the attention of the operator from the primary task at hand, which is maintaining intimate interpersonal interactions.

Movement in space may nonetheless prove beneficial in intergroup conflict scenarios when groups are not allowed to travel to the opposing group's location. In such cases, there is a political value in the ability to move around a forbidden area. Moreover, in asymmetric conflicts where the oppressed group suffers from tight movement restrictions in their day-to-day life, as is the situation in Palestine [22], an operator may feel empowered by having the ability to travel with their avatar. That, in turn, may contribute to a greater sense of equality and confidence within the conversation.

5.2   Nonverbal communication and emotional expression

Nonverbal communication (NVC) signals such as facial expressions, eye gaze, and bodily gestures play a substantial role in our day-to-day interactions. In telepresence-based contact, those signals need to be accurately picked up from the operator and portrayed using the telerobot's body without losing or changing their meaning.

In a pioneering work by Argyle [10], nonverbal signals were enumerated and categorized according to their level of awareness. The majority of them, as defined by Argyle, are *mostly unaware* on the part of the sender and *mostly aware* on the receiver side [10, p. 5]. For example, we are seldom aware that we are smiling during a conversation, but the sentiment is registered much more attentively with our conversation partner.

---

[8] https://www.softbankrobotics.com/emea/en/pepper

[9] https://research.samsung.com/robot

[10] https://www.doublerobotics.com/

[11] https://suitabletech.com/

[12] http://www.parorobots.com/

[13] http://www.geminoid.jp/en/robots.html

Since NVCs communicate emotion, we should handle them with great care in telepresence contact. Unaware emotional signals from the operator can be detected using facial recognition, prosodics, and body tracking, but modern deep learning systems are still subjected to noise and errors, and can only recognize generic emotions [55, 131]. A mistake in communicating an emotional state could lead to confusion and frustration in the conversation. Therefore, it may be safer to rely strictly on explicit gestures made by the operator with full awareness. Expression of emotions in an asymmetric system could be invoked by the operator using emojis [65] or other dedicated buttons that activate an emotional gesture in the robot. In body-tracking systems, explicit body gestures could be used (such as a thumbs-up, or a sign-language symbol), or touch-based interactions, such as a pat or a stroke on the robot's body, a high-five, or a hug.

Even if body signals are accurately detected, their meaning is not guaranteed to preserve across cultures. Gestures require active translation [48], and facial expressions are no longer regarded as universal [jackFacialExpressionsEmotion2012]. The problem further exacerbates when opting for a non-anthropomorphic avatar that does not have eyebrows and is not capable of granular gaze motion as in the humanoid SEER robot [121].

A possible solution could be to use the *flow* and *rhythm* of body movements to express emotions instead of explicitly formed gestures [51]. Dance is suggested to be cross-culturally universal [111], and much of our emotional states are expressed through the body rather than facial expressions [12]. Successful attempts that use movement as a mechanism for expression in robots have made use of existing frameworks and tools, including Laban's movement analysis (LMA) [**(author?)** [75];shafirEmotionRegulationMovement2016] in [**(author?)** [91];**(author?)** [84] and the PAD emotional state model [85] in [9, 93].

Some signals, such as shifts in gaze and body orientation, are completely unaware-of during the conversation, yet they have an impact on turn-taking and attention signaling [67, 105]. A smooth turn-taking flow can promote the sense of equality in contact, and it was demonstrated to benefit human-robot interaction [76, 122]. Turn-taking signals cannot be explicitly pronounced by the operator, without impairing the flow of the conversation. Instead, they should be a part of the robot's semi-autonomous functionality. In symmetric systems, end-of-turn could be predicted using several tracking modalities [35], while an asymmetric interface can infer the end-of-turn using typing and clicking indicators.

5.3   Verbal communication

Language, as defined by critical theorist Jürgen Habermas, is the medium through which we acquire a fundamental mutual-understanding between individuals [**(year?)**]. While its use may cause both de-escalation and escalation of the conflict, it is often the only tool available to convey layered and abstract information. In the CMC world, we may also use language in creative ways to make up for the lack of embodied interaction and nonverbal modalities [66].

The outstanding benefit of mediated verbal interaction for intergroup contact is the capacity to translate between different languages and dialects in real-time [7]. Often groups in conflict do not speak a common language and are required to speak in a third language in the language of the advantaged/majority group. This situation forms an obstacle to achieving equality in contact. Language translation may reinforce equality in communication, as all participants can express themselves in their native language. Machine translation, however, may also be destructive to cultural and political nuances [33, 81], and contemporary deep-learning translators exhibit stylistic and gender bias based on their training datasets [56, 116]. The loss of cultural context during translation can be especially harmful in conflict resolution [31], and new deep learning models are required for this task. On example is Timo Honkella's "peace machine" [53, 71], which focuses on preserving cultural-dependent meanings within a translation.

While no data exist on current implications of machine translation during intergroup contact, human translators and interpreters often suffer from a lack of trust by the participants who fear of bias and misinterpretation [89]; a machine translator may enfold similar risks. In our initial test for automatic language translation in contact between minority and majority groups in Finland, participants enjoyed their newly acquired ability to speak to one another in their language, but have raised concerns about being misrepresented by the machine [98].

Some mitigating steps could be taken to improve the experience of the participants. First, when using speech recognition, feedback of the result in the operator's native tongue should be provided, perhaps at the cost of delaying the flow of conversation. Second, when possible, the interface should display the confidence level of the translation before it gets sent to the other side. Finally, in case a mistake was realized by the operator only after submitting, there can be a quick "oops" button that has the robot express an apologizing gesture. If used according to those principles of design and interaction, real-time language translation could be an important facilitator for telepresence intergroup contact.

5.4   Synchrony, reciprocity and feedback

Synchrony and reciprocity facilitate interpersonal sympathy and empathy across all communication modalities [18, 24, 108]. The process is also referred to as "social entrainment" [102, 118]. It includes interactions such as rhythmic movements (e.g., clapping, jumping), a smooth conversation beat, synchronized dance, give-and-receive interactions, gaze synchrony, affective matching, and mimicry. Positive effects are also observed in human-robot interaction scenarios, particularly in cases of care and therapy robots for children and the elderly [11, 82].

Achieving interpersonal synchrony over mediated communication stumbles upon the problem of *latency* [27]. The unavoidable time delay due to physical distance between the participants can instill confusion and frustration when performing rhythmic and simultaneous tasks. Research in the field of online music performance

is at the forefront of tackling such issues [94] and can be used as an inspiration. Semi-autonomous methods in the likes of action prediction, lag compensation, and global metronomes enable musicians to collaborate in jam sessions from different locations around the globe. The same methods can assist in synchronizing robot-mediated activities. In symmetric systems, the participants would be coordinating the same action, for example, clapping. In asymmetric systems, one participant would use a control interface, for example, by tapping or shaking a mobile phone, while another would act in front of the telerobot.

Some reciprocal actions do not require real-time synchrony between the participants and could be implemented easily. For example, the above mentioned hand-shake example and other similar gestures such as a "high five" could be performed in a turn-based flow, where one participant reaches out first, and then the other reciprocates. Such actions may not have the same valence as real-time synchronization, but could still benefit the conversation due to their reciprocal nature. Additionally, people tend to be forgiving toward the sluggishness of robots, which may lower the sense of awkwardness that might occur during the use of reciprocal actions in an FtF encounter.

In asymmetric systems where the robot's operator is using a control interface, having instant feedback to the control actions provides a sense of reciprocity with the control medium and can increase perceived agency and ownership within the operator [37]. At the high-end of the spectrum, advanced control systems, such as the ones for 'Robonauts' at the Johnson Space Center [@ 32], mix Virtual Reality and haptic feedback. As a bare minimum, an operator should have visual feedback on how the robot acts in response to control commands.

In our initial experiment, participants expressed concern over their inability to see the facial expressions they were invoking with the robot, or their avatar's arm when it was being touched [98]. When designing an asymmetric control interface, it is necessary to provide maximum visibility of the telerobot's body to the operator. If one camera is not enough, multiple camera angles could be utilized. Additionally, placing mirrors on-site could allow the operators to examine their re-embodied appearance. Finally, practicing the use of the telerobot ahead of the encounter could help operators to get comfortable with the new interface without the pressure of the ensuing intergroup contact.

6   Discussion

The guidelines set forth in this article provide a foundation for further research and implementation of an innovative medium for intergroup contact. Any organized forms of intergroup contact should always be questioned and scrutinized regarding its internal motivation, especially in the context of violent, asymmetric conflict. When involving technology, a transparent and fully open-source strategy should be employed to expose inherent biases and avoid concentrations of power. The practice of *Co-Design* can increase the involvement of minority groups in the process, disseminate technological knowledge, and reduce the notion of a higher

power from above coming to restore peace without perceiving the situation and its nuances.

Moreover, Groom et al. showed that operators had a greater sense of self-extension to a robot that was assembled by them, rather than another [43]. Robots were also successfully co-designed with children as the target users [4, 50], and co-design methods improved the general attitude of students toward robots in educational settings [103].

Toward the first installment of telepresence robots in sensitive conflict situations, benefits and risks are to be carefully evaluated in dedicated focus groups and with A/B testing of particular features and interactions. We look forward to unveiling the potential of telepresence robots for intergroup contact in further research, ultimately leading to positive social change.

7   Appendix A: Summary table

Aspect	Hypothesis
	• An asymmetric system would invoke CMC related theories such as SIDE and hyperpersonal communication that are positive for contact, but only in one side of the conversation.
System architecture	• An asymmetric system may provide a power advantage for oppressed groups and highlight existing inequalities, but may also cause inconvenience to the participants.
	• A symmetric system would provide a more equal foundation for the conversation and a stronger sense of agency and ownership for the operators since the interface is transparent
Visual appearance	When choosing the level of anthropomorphism, the following should be considered: • A hig
Voice	A synthetic voice that maintains a human tone but is consistent with the non-anthropomor
Materiality	Use of soft materials and soft actuators: • Supports intimacy and empathy due to the relat
Co-design	A co-design approach to robotic avatars: • Increases operator self-extension toward the ava
Movement in space	Stationary robots: • Allow the operator to focus on the interaction rather than on mobility.
Nonverbal communication	• Turn-taking and attention signals such a gaze aversion promote the sense of equality. •
Verbal communication	• Automatic language translation could assist in communication, but is prone to error. • D
Synchrony, reciprocity and feedback	• Rhythmic synchronized activities such as dance and mimicry, as well as reciprocal action
Public space interventions	• External hints on group identity and a full exposure upon contact balance the potential
Interaction content	• Games support peacebuilding and may use the robot's body as a game controller. • Sem
Ethical considerations	• Recognizing existing power relations within the system and telerobot design may tackle

8   References

1. Ahmed, S.: Strange Encounters : Embodied Others in Post-Coloniality. Routledge, London (2000)

2. Al-Ghaith, W.: Understanding Social Network Usage: Impact of Co-Presence, Intimacy, and Immediacy. International Journal of Advanced Computer Science and Applications **6**(8) (2015). https://doi.org/10.14569/IJACSA.2015.060813

3. Allport, G.W.: The Nature of Prejudice. Addison-Wesley, Oxford, England (1954)

4. Alves-Oliveira, P., Arriaga, P., Paiva, A., Hoffman, G.: YOLO, a Robot for Creativity: A Co-Design Study with Children. In: Proceedings of the 2017 Conference on Interaction Design and Children. pp. 423–429. ACM, Stanford California USA (Jun 2017). https://doi.org/10.1145/3078072.3084304

5. Alvidrez, S., Peña, J.: Contact in VR: Testing avatar customisation and common ingroup identity cues on outgroup bias reduction. Annual Review of Cybertherapy and Telemedicine (2020)

6. Alvidrez, S., Peña, J.: Verbal Mimicry Predicts Social Distance and Social Attraction to an Outgroup Member in Virtual Reality. In: 2020 IEEE Inter-

national Conference on Artificial Intelligence and Virtual Reality (AIVR). pp. 68–73 (Dec 2020). https://doi.org/10.1109/AIVR50618.2020.00023

7. Amichai-Hamburger, Y.: Reducing intergroup conflict in the digital age. The handbook of intergroup communication pp. 181–193 (2012)

8. Andreasson, R., Alenljung, B., Billing, E., Lowe, R.: Affective Touch in Human–Robot Interaction: Conveying Emotion to the Nao Robot. International Journal of Social Robotics **10**(4), 473–491 (Sep 2018). https://doi.org/10.1007/s12369-017-0446-3

9. Ardila, L.R., Coronado, E., Hendra, H., Phan, J., Zainalkefli, Z., Venture, G.: Adaptive Fuzzy and Predictive Controllers for Expressive Robot Arm Movement during Human and Environment Interaction. International Journal of Mechanical Engineering and Robotics Research pp. 207–219 (2019). https://doi.org/10.18178/ijmerr.8.2.207-219

10. Argyle, M.: Bodily Communication. Routledge (2013)

11. Aucouturier, J.J., Ikeuchi, K., Hirukawa, H., Nakaoka, S., Shiratori, T., Kudoh, S., Kanehiro, F., Ogata, T., Kozima, H., Okuno, H.G., Michalowski, M.P., Ogai, Y., Ikegami, T., Kosuge, K., Takeda, T., Hirata, Y.: Cheek to Chip: Dancing Robots and AI's Future. IEEE Intelligent Systems **23**(2), 74–84 (Mar 2008). https://doi.org/10.1109/MIS.2008.22

12. Aviezer, H., Trope, Y., Todorov, A.: Body Cues, Not Facial Expressions, Discriminate Between Intense Positive and Negative Emotions. Science **338**(6111), 1225–1229 (Nov 2012). https://doi.org/10.1126/science.1224313

13. Bao, G., Fang, H., Chen, L., Wan, Y., Xu, F., Yang, Q., Zhang, L.: Soft robotics: Academic insights and perspectives through bibliometric analysis. Soft robotics **5**(3), 229–241 (2018)

14. Behm-Morawitz, E.: Mirrored selves: The influence of self-presence in a virtual world on health, appearance, and well-being. Computers in Human Behavior **29**(1), 119–128 (Jan 2013). https://doi.org/10.1016/j.chb.2012.07.023

15. Behm-Morawitz, E., Pennell, H., Speno, A.G.: The effects of virtual racial embodiment in a gaming app on reducing prejudice. Communication Monographs **83**(3), 396–418 (Jul 2016). https://doi.org/10.1080/03637751.2015.1128556

16. Belk, R.W.: Extended Self in a Digital World. Journal of Consumer Research **40**(3), 477–500 (Oct 2013). https://doi.org/10.1086/671052

17. Bente, G., Rüggenberg, S., Krämer, N.C., Eschenburg, F.: Avatar-Mediated Networking: Increasing Social Presence and Interpersonal Trust in Net-Based Collaborations. Human Communication Research **34**(2), 287–318 (Apr 2008). https://doi.org/10.1111/j.1468-2958.2008.00322.x

18. Bernieri, F.J., Rosenthal, R.: Interpersonal coordination: Behavior matching and interactional synchrony. (1991)

19. Bewley, H., Boer, L.: *Designing Blo-nut*: Design Principles, Choreography and Otherness in an Expressive Social Robot. In: Proceedings of the 2018 on Designing Interactive Systems Conference 2018 - DIS '18. pp. 1069–1080. ACM Press, Hong Kong, China (2018). https://doi.org/10.1145/3196709.3196817

20. Bonarini, A., Garzotto, F., Gelsomini, M., Romero, M., Clasadonte, F., Yilmaz, A.N.Ç.: A huggable, mobile robot for developmental disorder interventions in a multi-modal interaction space. In: 2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN). pp. 823–830 (Aug 2016). https://doi.org/10.1109/ROMAN.2016.7745214

21. Broekens, J., Heerink, M., Rosendal, H.: Assistive social robots in elderly care: A review. Gerontechnology **8**(2), 94–103 (Apr 2009). https://doi.org/10.4017/gt.2009.08.02.002.00

22. Brown, A.P.: The Immobile Mass: Movement Restrictions in the West Bank. Social & Legal Studies **13**(4), 501–521 (Dec 2004). https://doi.org/10.1177/0964663904047331

23. Brown, R., Hewstone, M.: An integrative theory of intergroup contact. Advances in experimental social psychology **37**(37), 255–343 (2005)

24. Burgoon, J.K., Dillman, L., Stem, L.A.: Adaptation in Dyadic Interaction: Defining and Operationalizing Patterns of Reciprocity and Compensation. Communication Theory **3**(4), 295–316 (1993). https://doi.org/10.1111/j.1468-2885.1993.tb00076.x

25. Burgoon, J.K., Hoobler, G.D.: Nonverbal signals. Handbook of interpersonal communication **2**, 229–285 (1994)

26. Campanella, T.: Eden by wire: Webcameras and the telepresent landscape. pp. 22–46 (Jan 2000)

27. Campbell, J.: Interpersonal Coordination in Computer-Mediated Communication. In: Encyclopedia of Information Science and Technology, Third Edition, pp. 2079–2088. IGI Global (2015)

28. Casanueva, J., Blake, E.: The effects of avatars on co-presence in a collaborative virtual environment (2001)

29. Choi, J.J., Kwak, S.S.: Can you feel me?: How embodiment levels of telepresence systems affect presence. In: 2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN). pp. 606–611. IEEE, New York, NY, USA (Aug 2016). https://doi.org/10.1109/ROMAN.2016.7745180

30. Choi, J.J., Kwak, S.S.: Who is this?: Identity and presence in robot-mediated communication. Cognitive Systems Research **43**, 174–189 (Jun 2017). https://doi.org/10.1016/j.cogsys.2016.07.006

31. Cohen, R.: Language and Conflict Resolution: The Limits of English. International Studies Review **3**(1), 25–51 (2001). https://doi.org/10.1111/1521-9488.00224

32. Cole, J., Sacks, O., Waterman, I.: On the immunity principle: A view from a robot. Trends in Cognitive Sciences **4**(5),   167 (May 2000). https://doi.org/10.1016/S1364-6613(00)01459-5

33. Cronin, M.: Translation in the Digital Age. Routledge, first edn. (Nov 2012). https://doi.org/10.4324/9780203073599

34. Danese, E.: Soft machine. Machines That Become Us: The Social Context of Personal Communication Technology pp. 267–276 (2003)

35. de Kok, I., Heylen, D.: Multimodal end-of-turn prediction in multi-party meetings. In: Proceedings of the 2009 International Conference on Multimodal Interfaces - ICMI-MLMI '09. p. 91. ACM Press, Cambridge, Massachusetts, USA (2009). https://doi.org/10.1145/1647314.1647332

36. Del Vicario, M., Vivaldo, G., Bessi, A., Zollo, F., Scala, A., Caldarelli, G., Quattrociocchi, W.: Echo chambers: Emotional contagion and group polarization on facebook. Scientific reports **6**, 37825 (2016)

37. Dolezal, L.: The Remote Body: The Phenomenology of Telepresence and Re-Embodiment. Human Technology **5**(November), 208–226 (2009)

38. Fox, J., Ahn, S.J.G., Janssen, J.H., Yeykelis, L., Segovia, K.Y., Bailenson, J.N.: Avatars Versus Agents: A Meta-Analysis Quantifying the Effect of Agency on Social Influence. Human–Computer Interaction **30**(5), 401–432 (Sep 2015). https://doi.org/10.1080/07370024.2014.921494

39. Gallagher, S.: Philosophical conceptions of the self: Implications for cognitive science. Trends in Cognitive Sciences **4**(1), 14–21 (Jan 2000)

40. Gallagher, S.: How the Body Shapes the Mind. Clarendon Press (2006)

41. Gibson, J.J.: The senses considered as perceptual systems. (1966)

42. Goffman, E.: Behavior in Public Places. Simon and Schuster (2008)

43. Groom, V., Takayama, L., Ochi, P., Nass, C.: I am my robot: The impact of robot-building and robot form on operators. In: Proceedings of the 4th ACM/IEEE International Conference on Human Robot Interaction - HRI '09. p. 31. ACM Press, La Jolla, California, USA (2009). https://doi.org/10.1145/1514095.1514104

44. Habermas, J.: The Theory of Communicative Action, vol. 1. Beacon Press, Boston (1984)

45. Hancock, P.A., Billings, D.R., Schaefer, K.E., Chen, J.Y.C., de Visser, E.J., Parasuraman, R.: A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction. Human Factors: The Journal of the Human Factors and Ergonomics Society **53**(5), 517–527 (Oct 2011). https://doi.org/10.1177/0018720811417254

46. Hannaford, B.: Feeling Is Believing: A History of Telerobotics. The Robot in the Garden: Telerobotics and Telepistemology in the Age of the Internet. Edited by Ken Goldberg. The MIT Press (2000)

47. Hasler, B.S., Hirschberger, G., Shani-Sherman, T., Friedman, D.A.: Virtual Peacemakers: Mimicry Increases Empathy in Simulated Contact with Virtual Outgroup Members. Cyberpsychology, Behavior, and Social Networking **17**(12), 766–771 (Dec 2014). https://doi.org/10.1089/cyber.2014.0213

48. Hasler, B.S., Salomon, O., Tuchman, P., Lev-Tov, A., Friedman, D.: Real-time gesture translation in intercultural communication. AI & SOCIETY **32**(1), 25–35 (Feb 2017). https://doi.org/10.1007/s00146-014-0573-4

49. Hayles, N.K.: Speculative aesthetics and object-oriented inquiry (OOI). Speculations: A journal of speculative realism **5**, 158–79 (2014)

50. Henkemans, O.B., Neerincx, M., Pal, S., Van Dam, R., Hong, J.S., Oleari, E., Pozzi, C., Sardu, F., Sacchitelli, F.: Co-Design of the Pal Robot and Avatar That Perform Joint Activities with Children for Improved Diabetes Self-Management. New York: IEEE Press (2016)

51. Hoffman, G., Ju, W.: Designing Robots With Movement in Mind. Journal of Human-Robot Interaction **3**(1), 89–122 (Mar 2014). https://doi.org/10.5898/JHRI.3.1.Hoffman

52. Hoffman, G., Zuckerman, O., Hirschberger, G., Luria, M., Shani-Sherman, T.: Design and Evaluation of a Peripheral Robotic Conversation Companion. In: 2015 10th ACM/IEEE International Conference on Human-Robot Interaction (HRI). pp. 3–10 (Mar 2015)

53. Honkela, T.: Rauhankone: Tekoälytutkijan testamentti (2017)

54. Hook, D.: The 'real' of racializing embodiment. Journal of Community & Applied Social Psychology **18**(2), 140–152 (Mar 2008). https://doi.org/10.1002/casp.963

55. Hossain, M.S., Muhammad, G.: Emotion recognition using deep learning approach from audio–visual emotional big data. Information Fusion **49**, 69–78 (Sep 2019). https://doi.org/10.1016/j.inffus.2018.09.008

56. Hovy, D., Bianchi, F., Fornaciari, T.: Can You Translate that into Man? Commercial Machine Translation Systems Include Stylistic Biases. In: Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics (2020)

57. Hughes, C.E.: Human Surrogates: Remote Presence for Collaboration and Education in Smart Cities. In: Proceedings of the 1st International Workshop on Emerging Multimedia Applications and Services for Smart Cities - EMASC '14. pp. 1–2. ACM Press, Orlando, Florida, USA (2014). https://doi.org/10.1145/2661704.2661712

58. Hwang, J., Sangyup Lee, Sang Chul Ahn, Hyoung-gon Kim: Augmented robot agent: Enhancing co-presence of the remote participant. In: 2008 7th IEEE/ACM International Symposium on Mixed and Augmented Reality. pp. 161–162. IEEE, Cambridge, UK (Sep 2008). https://doi.org/10.1109/ISMAR.2008.4637346

59. Jia, Y., Zhang, Y., Weiss, R.J., Wang, Q., Shen, J., Ren, F., Chen, Z., Nguyen, P., Pang, R., Moreno, I.L., Wu, Y.: Transfer Learning from Speaker Verification to Multispeaker Text-To-Speech Synthesis. arXiv:1806.04558 [cs, eess] (Jan 2019)

60. Jin, S.A.A., Park, N.: Parasocial Interaction with My Avatar: Effects of Interdependent Self-Construal and the Mediating Role of Self-Presence in an Avatar-Based Console Game, Wii. CyberPsychology & Behavior **12**(6), 723–727 (Dec 2009). https://doi.org/10.1089/cpb.2008.0289

61. Johnson, N.A., Cooper, R.B., Chin, W.W.: Anger and flaming in computer-mediated negotiation among strangers. Decision Support Systems **46**(3), 660–672 (Feb 2009). https://doi.org/10.1016/j.dss.2008.10.008

62. Jørgensen, J.: Appeal and Perceived Naturalness of a Soft Robotic Tentacle. In: Companion of the 2018 ACM/IEEE International Conference on Human-Robot Interaction. pp. 139–140. ACM, Chicago IL USA (Mar 2018). https://doi.org/10.1145/3173386.3176985

63. Jung, M.F., Martelaro, N., Hinds, P.J.: Using Robots to Moderate Team Conflict: The Case of Repairing Violations. In: Proceedings of the Tenth Annual ACM/IEEE International Conference on Human-Robot Interaction. pp. 229–236. HRI '15, Association for Computing Machinery, New York, NY, USA (Mar 2015). https://doi.org/10.1145/2696454.2696460

64. Kac, E.: Telepresence and Bio Art : Networking Humans, Rabbits and Robots. University of Michigan Press, Ann Arbor (2005)

65. Kaye, L.K., Malone, S.A., Wall, H.J.: Emojis: Insights, Affordances, and Possibilities for Psychological Science. Trends in Cognitive Sciences **21**(2), 66–68 (Feb 2017). https://doi.org/10.1016/j.tics.2016.10.007

66. Keating, E.: Challenges of Conducting Interaction with Technologically Mediated Bodies. In: Intercorporeality: Emerging Socialities in Interaction, p. 303. Oxford University Press (2017)

67. Kendon, A.: Conducting Interaction: Patterns of Behavior in Focused Encounters, vol. 7. CUP Archive (1990)

68. Kenworthy, J.B., Turner, R.N., Hewstone, M., Voci, A.: Intergroup contact: When does it work, and why. On the nature of prejudice: Fifty years after Allport pp. 278–292 (2005)

69. Kerruish, E.: Affective Touch in Social Robots. Transformations (14443775) (29) (2017)

70. Kidd, C., Taggart, W., Turkle, S.: A sociable robot to encourage social interaction among the elderly. In: Proceedings 2006 IEEE International Conference on Robotics and Automation, 2006. ICRA 2006. pp. 3972–3976. IEEE, Orlando, FL, USA (2006). https://doi.org/10.1109/ROBOT.2006.1642311

71. Koulu, R., Kontiainen, L.E.: How Will AI Shape the Future of Law? (2019)

72. Kozima, H., Nakagawa, C.: Social robots for children: Practice in communication-care. In: 9th IEEE International Workshop on Advanced Motion Control, 2006. pp. 768–773. IEEE, Istanbul, Turkey (2006). https://doi.org/10.1109/AMC.2006.1631756

73. Kress, G.: Multimodality: A Social Semiotic Approach to Contemporary Communication. Routledge (2009)

74. Kristoffersson, A., Coradeschi, S., Loutfi, A.: A Review of Mobile Robotic Telepresence. Advances in Human-Computer Interaction **2013**, 1–17 (2013). https://doi.org/10.1155/2013/902316

75. Laban, R., Ullmann, L.: The Mastery of Movement (Jan 1971)

76. Lala, D., Inoue, K., Kawahara, T.: Smooth Turn-taking by a Robot Using an Online Continuous Model to Generate Turn-taking Cues. In: 2019 International Conference on Multimodal Interaction. pp. 226–234. ICMI '19, Association for Computing Machinery, Suzhou, China (Oct 2019). https://doi.org/10.1145/3340555.3353727

77. Latour, B.: We Have Never Been Modern. Harvard university press (2012)

78. Latour, B.: Down to Earth: Politics in the New Climatic Regime. John Wiley & Sons (2018)

79. Lee, H., Kim, Y.H., Lee, K.k., Yoon, D.K., You, B.J.: Designing the appearance of a telepresence robot, M4K: A case study. In: International Workshop on Cultural Robotics. pp. 33–43. Springer (2015)

80. Lee, K.M., Nass, C.: Social-Psychological Origins of Feelings of Presence: Creating Social Presence With Machine-Generated Voices. Media Psychology **7**(1), 31–45 (Feb 2005). https://doi.org/10/d2nzn3

81. Lehman-Wilzig, S.: The Tower of Babel vs the power of babble: Future political, economic and cultural consequences of synchronous, automated translation systems (SATS). New Media & Society **2**(4), 467–494 (2000)

82. Lorenz, T., Weiss, A., Hirche, S.: Synchrony and Reciprocity: Key Mechanisms for Social Companion Robots in Therapy and Care. International Journal of Social Robotics **8**(1), 125–143 (Jan 2016). https://doi.org/10.1007/s12369-015-0325-8

83. Maoz, I.: Evaluating the Communication between Groups in Dispute: Equality in Contact Interventions between Jews and Arabs in Israel. Negotiation Journal **21**(1), 131–146 (2005). https://doi.org/10.1111/j.1571-9979.2005.00050.x

84. Masuda, M., Kato, S.: Motion rendering system for emotion expression of human form robots based on Laban movement analysis. In: 19th International Symposium in Robot and Human Interactive Communication. pp. 324–329. IEEE, Viareggio, Italy (Sep 2010). https://doi.org/10.1109/ROMAN.2010.5598692

85. Mehrabian, A., Russell, J.A.: An Approach to Environmental Psychology. the MIT Press (1974)

86. Michaud, F., Boissy, P., Labonte, D., Corriveau, H., Grant, A., Lauria, M., Cloutier, R., Roux, M.A., Iannuzzi, D., Royer, M.P.: Telepresence Robot for Home Care Assistance. In: AAAI Spring Symposium: Multidisciplinary Collaboration for Socially Assistive Robotics. pp. 50–55. California, USA (2007)

87. Minsky, M.: Telepresence (1980)

88. Mitchell, W.J., Szerszen, K.A., Lu, A.S., Schermerhorn, P.W., Scheutz, M., MacDorman, K.F.: A Mismatch in the Human Realism of Face and Voice Produces an Uncanny Valley. i-Perception **2**(1), 10–12 (Jan 2011). https://doi.org/10.1068/i0415

89. Monzó-Nebot, E.: Translators and interpreters as agents of diversity. Managing myths and pursuing justice in postmonolingual societies. Translating and Interpreting Justice in a Postmonolingual Age p. 9 (2019)

90. Nagendran, A., Steed, A., Kelly, B., Pan, Y.: Symmetric telepresence using robotic humanoid surrogates: Robotic symmetric telepresence. Computer Animation and Virtual Worlds **26**(3-4), 271–280 (May 2015). https://doi.org/10.1002/cav.1638

91. Nakata, T., Sato, T., Mori, T., Mizoguchi, H.: Expression of emotion and intention by robot body movement. In: Proceedings of the 5th International Conference on Autonomous Systems (1998)

92. Nie, J., Pak, M., Marin, A.L., Sundar, S.S.: Can you hold my hand?: Physical warmth in human-robot interaction. In: Proceedings of the Seventh Annual ACM/IEEE International Conference on Human-Robot Interaction - HRI '12. p. 201. ACM Press, Boston, Massachusetts, USA (2012). https://doi.org/10.1145/2157689.2157755

93. Noguchi, Y., Tanaka, F.: OMOY: A Handheld Robotic Gadget that Shifts its Weight to Express Emotions and Intentions. In: Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems. pp. 1–13. ACM, Honolulu HI USA (Apr 2020). https://doi.org/10.1145/3313831.3376775

94. Oda, R.K.: Tools and Techniques for Rhythmic Synchronization in Networked Musical Performance. Ph.D. thesis, Princeton University (2017)

95. Ogawa, K., Nishio, S., Koda, K., Taura, K., Minato, T., Ishii, C.T., Ishiguro, H.: Telenoid: Tele-presence android for communication. In: ACM SIGGRAPH 2011 Emerging Technologies on - SIGGRAPH '11. pp. 1–1. ACM Press, Vancouver, British Columbia, Canada (2011). https://doi.org/10.1145/2048259.2048274

96. Pagotto, L., Voci, A., Maculan, V.: The effectiveness of intergroup contact at work: Mediators and moderators of hospital workers' prejudice towards immigrants. Journal of Community & Applied Social Psychology **20**(4), 317–330 (Apr 2010). https://doi.org/10.1002/casp.1038

97. Paynter, H.M.: Analysis and Design of Engineering Systems. MIT press (1961)

98. Peled, A.: Soft Robotic Incarnation (2019)

99. Peled, A., Leinonen, T., Hasler, B.: The Potential of Telepresence Robots for Intergroup Contact:. In: Proceedings of the 4th International Conference on Computer-Human Interaction Research and Applications. pp. 210–217. SCITEPRESS - Science and Technology Publications, Budapest, Hungary (2020). https://doi.org/10.5220/0010148102100217

100. Peña, J., Wolff, G., Wojcieszak, M.: Virtual Reality and Political Outgroup Contact: Can Avatar Customization and Common Ingroup Identity Reduce Social Distance? Social Media + Society **7**(1), 2056305121993765 (Jan 2021). https://doi.org/10.1177/2056305121993765

101. Pettigrew, T.F.: Intergroup contact theory. Annual review of psychology **49**(1), 65–85 (1998)

102. Phillips-Silver, J., Aktipis, C.A., A. Bryant, G.: The Ecology of Entrainment: Foundations of Coordinated Rhythmic Movement. Music Perception **28**(1), 3–14 (Sep 2010). https://doi.org/10.1525/mp.2010.28.1.3

103. Reich-Stiebert, N., Eyssel, F., Hohnemann, C.: Involve the user! Changing attitudes toward robots by user participation in a robot prototyping process. Computers in Human Behavior **91**, 290–296 (Feb 2019). https://doi.org/10.1016/j.chb.2018.09.041

104. Rich, S.I., Wood, R.J., Majidi, C.: Untethered soft robotics. Nature Electronics **1**(2), 102–112 (2018). https://doi.org/10.1038/s41928-018-0024-1

105. Richardson, D.C., Dale, R., Tomlinson, J.M.: Conversation, Gaze Coordination, and Beliefs About Visual Context. Cognitive Science **33**(8), 1468–1482 (2009). https://doi.org/10.1111/j.1551-6709.2009.01057.x

106. Rifinski, D., Erel, H., Feiner, A., Hoffman, G., Zuckerman, O.: Human-human-robot interaction: Robotic object's responsive gestures improve interpersonal evaluation in human interaction. Human–Computer Interaction pp. 1–27 (Feb 2020). https://doi.org/10.1080/07370024.2020.1719839

107. Schumann, S., Klein, O., Douglas, K., Hewstone, M.: When is computer-mediated intergroup contact most promising? Examining the effect of out-group members' anonymity on prejudice. Computers in Human Behavior **77**, 198–210 (Dec 2017). https://doi.org/10.1016/j.chb.2017.08.006

108. Sevdalis, V., Keller, P.E.: Captured by motion: Dance, action understanding, and social cognition. Brain and Cognition **77**(2), 231–236 (Nov 2011). https://doi.org/10.1016/j.bandc.2011.08.005

109. Shen, S., Slovak, P., Jung, M.F.: "Stop. I See a Conflict Happening.": A Robot Mediator for Young Children's Interpersonal Conflict Resolution. In: Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction. pp. 69–77. ACM, Chicago IL USA (Feb 2018). https://doi.org/10.1145/3171221.3171248

110. Sheridan, T.B.: Teleoperation, telerobotics and telepresence: A progress report. Control Engineering Practice **3**(2), 205–214 (Feb 1995). https://doi.org/10.1016/0967-0661(94)00078-U

111. Sievers, B., Polansky, L., Casey, M., Wheatley, T.: Music and movement share a dynamic structure that supports universal expressions of emotion. Proceedings of the National Academy of Sciences **110**(1), 70–75 (Jan 2013). https://doi.org/10.1073/pnas.1209023110

112. Silva, S.: Reification and Fetishism: Processes of Transformation. Theory, Culture & Society **30**(1), 79–98 (Jan 2013). https://doi.org/10.1177/0263276412452892

113. Söeffner, J., Nam, C.S.: Co-presence in shared virtual environments: Avatars beyond the opposition of presence and representation. In: International Conference on Human-Computer Interaction. pp. 949–958. Springer (2007)

114. Spears, R., Postmes, T., Lea, M., Wolbert, A.: When are net effects gross products? Communication. Journal of Social Issues **58**(1), 91–107 (2002)

115. STANO, S.: The Internet and the Spread of Conspiracy Content (2020)

116. Stanovsky, G., Smith, N.A., Zettlemoyer, L.: Evaluating gender bias in machine translation. arXiv preprint arXiv:1906.00591 (2019)

117. Stiehl, W., Lieberman, J., Breazeal, C., Basel, L., Lalla, L., Wolf, M.: Design of a therapeutic robotic companion for relational, affective touch.

In: ROMAN 2005. IEEE International Workshop on Robot and Human Interactive Communication, 2005. pp. 408–415. IEEE, Nashville, TN, USA (2005). https://doi.org/10.1109/ROMAN.2005.1513813

118. Stupacher, J., Wood, G., Witte, M.: Synchrony and sympathy: Social entrainment with music compared to a metronome. Psychomusicology: Music, Mind, and Brain **27**(3), 158–166 (2017). https://doi.org/10.1037/pmu0000181

119. Tanaka, F., Takahashi, T., Matsuzoe, S., Tazawa, N., Morita, M.: Telepresence robot helps children in communicating with teachers who speak a different language. In: Proceedings of the 2014 ACM/IEEE International Conference on Human-Robot Interaction - HRI '14. pp. 399–406. ACM Press, Bielefeld, Germany (2014). https://doi.org/10.1145/2559636.2559654

120. Thrun, S.: Toward a Framework for Human-Robot Interaction. Human–Computer Interaction **19**(1-2), 9–24 (Jun 2004). https://doi.org/10.1080/07370024.2004.9667338

121. Todo, T.: SEER: Simulative emotional expression robot. In: ACM SIGGRAPH 2018 Emerging Technologies. pp. 1–2. ACM, Vancouver British Columbia Canada (Aug 2018). https://doi.org/10.1145/3214907.3214921

122. Vázquez, M., Carter, E.J., McDorman, B., Forlizzi, J., Steinfeld, A., Hudson, S.E.: Towards Robot Autonomy in Group Conversations: Understanding the Effects of Body Orientation and Gaze. In: 2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI. pp. 42–52 (Mar 2017)

123. Voci, A., Hewstone, M.: Intergroup Contact and Prejudice Toward Immigrants in Italy: The Mediational Role of Anxiety and the Moderational Role of Group Salience. Group Processes & Intergroup Relations **6**(1), 37–54 (Jan 2003). https://doi.org/10.1177/1368430203006001011

124. Walker, C.Y.Z.K.: Soft grippers not only grasp fruits: From affective to psychotropic HRI. Louis-Philippe Demers's keynote talk 'Experiencing the Machine Alterity'offered unique insights into situated bodies in motion and how we perceive their agency beyond morphological mimicry. Demers is Director of the Creative Lab at QUT p. 15 (2019)

125. Walther, J.B.: Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. Communication research **23**(1), 3–43 (1996)

126. Walther, J.B., Hoter, E., Ganayem, A., Shonfeld, M.: Computer-mediated communication and the reduction of prejudice: A controlled longitudinal field experiment among Jews and Arabs in Israel. Computers in Human Behavior **52**, 550–558 (Nov 2015). https://doi.org/10.1016/j.chb.2014.08.004

127. Waqas, A., Salminen, J., Jung, S.g., Almerekhi, H., Jansen, B.J.: Mapping online hate: A scientometric analysis on research trends and hotspots

in research on online hate. PLOS ONE **14**(9), e0222194 (Sep 2019). https://doi.org/10.1371/journal.pone.0222194

128. White, F.A., Harvey, L.J., Abu-Rayya, H.M.: Improving Intergroup Relations in the Internet Age: A Critical Review. Review of General Psychology **19**(2), 129–139 (Jun 2015). https://doi.org/10.1037/gpr0000036

129. Willemse, C.J.A.M., Toet, A., van Erp, J.B.F.: Affective and Behavioral Responses to Robot-Initiated Social Touch: Toward Understanding the Opportunities and Limitations of Physical Contact in Human–Robot Interaction. Frontiers in ICT **4**, 12 (May 2017). https://doi.org/10.3389/fict.2017.00012

130. Yee, N., Bailenson, J.N., Ducheneaut, N.: The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior. Communication Research **36**(2), 285–312 (Apr 2009). https://doi.org/10.1177/0093650208330254

131. Zhang, S., Zhang, S., Huang, T., Gao, W.: Multimodal Deep Convolutional Neural Network for Audio-Visual Emotion Recognition. In: Proceedings of the 2016 ACM on International Conference on Multimedia Retrieval - ICMR '16. pp. 281–284. ACM Press, New York, New York, USA (2016). https://doi.org/10.1145/2911996.2912051

132. Žižek, S.: First as Tragedy, Then as Farce. Verso (2009)