Making Sense with Social Robots: Extending the Landscape of Investigation in HRI

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Abstract

The aim of this position paper is to propose a reflection on how to account for and investigate the many ways in which interaction between robots and humans requires co-ordination, negotiation or reformulation of meanings emerging in the ongoing interaction. Towards this aim, we argue, a perspective shift may be needed: to frame interactions as social engagements whose meaning can only be understood by the standpoint of those participating in it. We first present research on psychological benchmarks and design patterns for sociality in the HRI field. Then we provide arguments for including a new interactional element currently missing in the literature: participatory sense-making processes. As we will argue, such elements can be conceived and operationalised both as a relational benchmark as well as an interactional pattern, therefore proving useful for HRI research.

Keywords

Human-robot interaction, engagement, participatory sense-making

1. Introduction

Over the past decades research into human interaction with robots (HRI) has flourished, mostly thanks to both continuous advancements in AI technology and a germination of research practices and reflections from disciplines such as philosophy, neuroscience and cognitive science. One of the most uncontroversial findings emerged from HRI research is that people behave socially with robots in several ways and to different degrees, depending on an array of robot-related aspects such as, among others, human-likeness, conversational capacities, quality of a robot's emotional display. The aim of this position paper is to propose a reflection on how to account for and investigate the many ways in which interaction between robots and humans requires co-ordination, negotiation or reformulation of meanings emerging in the ongoing interaction. We argue that a perspective shift is needed and propose to frame interactions as social engagements whose meanings are created and understood on-line by the participants. *How can our proposal be applied to the research on human-robot interaction*? First, by clarify how the situated moves of humans and robots influence and cause each other within dynamical, sequentially coordinated processes. Second, by designing research paradigms that are based in the practices of human sense-making in real social encounters. We suggest that both strategies can open the way to new conversational, participatory or self-reflective, practices adopted and explored within HRI. Modelling HRI on participatory sense-making would mean abandoning the paradigm of individual cognition as the foundation of HRI and focusing on what individuals achieve together, thus putting the emphasis on the *relation* and its interaction dynamics. Towards this aim, we will first present research on psychological benchmarks and design patterns for sociality in the HRI field. Then we will provide arguments for including a new interactional element currently missing in HRI: participatory sense-making [1]. We will argue that participatory sense-making can be conceived and operationalised both as a relational benchmark and an interactional pattern, and therefore will prove useful for HRI research.

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2. Are computers social actors?

The relationship between humans and social technologies has been the core of a long-established epistemological debate on the nature of autonomous robotic agents, but also and above all on the future directions this relationship may take, with its social, cultural and economic consequences. Since the early Macy Conferences on Cybernetics (1946-1953), the interest in exploring the nature of human-robot interaction (HRI) has been growing with the purpose of "to better understand human relations, and to design future collaborations between humans and machines" [2].

At the beginning of the 1990, a major shift in the field was advanced by the Computers Are Social Actors framework (CASA) [3, 4], a new paradigm for studying human-robot interaction based on the media equation, or the incapacity to distinguish mediated representations from their real-life counterparts. CASA assumes that humans naturally treat computers like real interactants, applying mental models and social scripts that are normally used with humans, also to social technologies [5]. With some modifications to the key hypotheses and methods, the main concept behind the CASA framework has been successfully applied throughout HRI research to show that people do assign personality and affective traits to computers [6]; make judgments and inferences according to the computer's behaviour [7, 8] or appearance [9, 10] and apply stereotypes [11] and moral norms [12, 13, 14]. People act as if the computers were human, even though they understand that ontologically, computers are not human beings.

Much of the growing CASA-oriented body of research has been guided by the underlying question: what are social robots, in the eyes of a human being; and which physical, psychological, communicative features contribute to make them so? In the attempt to address this question, Kahn and colleagues [15] have proposed a first distinction between ontological and psychological explanatory claims about HRI. The ontological claim focuses on *what the humanoid robot actually is*, while the psychological claim focuses on *what functions people attribute to humanoid robotic agents, how and to what extent they do so under which circumstances*. As it was originally posed by Hofstadter and Dennett [16], the ontological question mainly turned around the very concept of self-consciousness and its access by computers or artificially created agents. Since then, extensive debate in cognitive science and AI has focused on whether artificial agents, as we can conceive of them today in material and structure, are capable of consciousness. At the same time, the psychological aspects of HRI have received just as much attention, reflected in studies investigating how to make socially competent robots and what their competences would afford for in social encounters with humans. Noteworthy, in some cases drawing a clear line between what an artificial agent is, and what it is perceived to be from a human's eye might be difficult. Partially because the ontological nature of any living system or agent determines its social affordances, and how those are perceived by those interacting with it. So, for instance, if we know that dogs are animals, and we know that animals cannot talk the way we do, then we should not expect our house dog to respond to us when we ask it: "do you want some food?" (ontological claim). And yet, this knowledge does not prevent us to keep interrogating the poor dog as if it had human-like communicative properties (psychological claim). The same may be equally true with artificial agents, with the exception that in this case their ontological nature is somehow established by, and therefore bound to, their creators (that is, by human beings). And despite all humans' attempts to make them autonomous systems, most of the current artificial agents are designed to model, and appropriately respond to, humans' psychological, social, cognitive, motor, affective capacities (as the CASA framework shows).

An initial step towards addressing and reflecting upon both these claims with sharper lens is to establish psychological benchmarks [15] of the things that are foundational for human interactions, and how to translate them into testable interactional scenarios. The scenarios were defined in terms of design patterns for sociality [17, 18].

3. Things that make HRI successful: psychological benchmarks and design patterns

In 2007, Kahn and colleagues outlined a non-exhaustive list of nine benchmarks intended as key aspects characterising fundamental categories of social and moral interactions between humans. They defined benchmarks as "categories of interaction that capture conceptually fundamental aspects of human life, specified abstractly enough so as to resist their identity as a mere psychological instrument (…) but capable of being translated into testable empirical propositions" [15] and identified as *autonomy, imitation, intrinsic moral value, moral accountability, privacy, reciprocity, conventionality, creativity, and authenticity of relation.* The overarching aim of pinning down human interactional benchmarks and transpose them into HRI equivalents was to advance the current understanding of what makes human-robot interactions successful considering the entirety of possible human relational experiences, from social to moral and thus began "to explicate what an interactional theory (as opposed to a use model) could look like for HRI" [15][2].

Drawing upon their psychological benchmarks framework, Kahn and his colleagues started to explored the micro-dynamics of HRI by identifying recurrent interactional design patterns occurring between children and a social robot (namely, Robovie) in several lab-based social situations and settings. A preliminary set of eight design patterns was systematically identified and coded: *initial introduction, didactic communication, in motion together, personal interests and history, recovering from mistakes, reciprocal turn-taking in game context, physical intimacy, and claiming unfair treatment or wrongful harm*. As this was a preliminary proposal, the authors specified that further combinations, hierarchical integrations and specifications between and within patterns would be just as likely as desirable Kahn's work was precious in combining the theoretical tenets of human sociality with a data-driven approach to implement empirical categories derived from the situated observation of interactional patterns between humans and social robots.

Among the many aspects covered by the work of Kahn and his colleagues, we think there is one missing: the situated and dynamic coordination and negotiation of meanings, intentions, expectations and interpretations that human beings experience on a daily basis in their social contexts. To exemplify, consider transition between one interactive sequence and another – e.g., meeting at the restaurant moving from greeting ritual to the issue of deciding who sits where - requiring co-agents' online coordination to make sense of the other's action and enable the continuous unfolding of action sequences. We take this to be an instance of participatory-sense making, and in what follows we propose to expand the current landscape of design patterns of HRI to include dynamical and situated processes of shared sense-making as a central feature of meaningful engagements between interactants.

4. Extending the landscape: engagement and sense-making between humans and SR

4.1. Social interactions as meaningful engagements between participants

With the aim of extending the current landscape of interactional possibilities between humans and social robots, we will start by discussing two theoretical frameworks of social interaction and consider what contributions these frameworks may offer to the field of HRI. The first account is the second-person approach to engagement, which defines social interactions as the embodied, situated meaningful engagement between persons. Within this framework, interactors are active participants engaging in situated, open-ended, experience-dependent action dialogues, sustained by a reciprocal understanding and coordination of their embodied, mutual presence. This presence is construed as interactants address and acknowledge each other intersubjectively as a "you". Engagement, in this approach, captures the qualitative aspect of social interactions [19] as it constitutes the very process by which interactant's reciprocal, direct experience of understanding and knowing each other unfolds. It also reflects the way this experience is described in everyday language (e.g., "being in sync with someone"). "Experientially, engagement is the fluctuating feelings of connectedness with one another, including that of being in the flow of an interaction" [20].

The second account is enactive philosophy, according to which

> "Social interaction is the regulated coupling between at least two autonomous agents, where the regulation is aimed at aspects of the coupling itself so that it constitutes an emergent autonomous organization in the domain of relational dynamics, without destroying in the process the autonomy of the agents involved" [21]

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[2]Please refer to the original article by Kahn and colleagues [15, 17] for detailed descriptions of benchmarks and design patterns. Full reference to the articles can be found in the list of references.

Enactivism considers sociality in its broadest form as the meaningful engagement between (embodied) subjects. Engagement occurs along a life-mind continuum based on six mutually supporting, operational concepts: *autonomy, sense-making, embodiment, emergence, experience, and participatory sense-making* [1, 22]. Each of these principles constitutes and supports the way living (cognising) organisms meaningfully engage with their environment, by means of their self-organizing and self-maintaining properties, as well as how they know and make sense of this environment - how they cognise with and about it. Social cognition, on an enactive account, is a process of *knowing-in-connection* [23], fundamentally a social and embodied process integrated with the bodily action and experience of the cogniser and enacted within interactions; certainly not simply something 'in the head' of individuals – i.e., in terms of mechanisms, computations, representations.

Participatory sense-making

Under this view, 'sense-making' becomes 'participatory' insofar as social dynamics, such as dynamical coordination of actions and affects, take over individual sense-making [21]. Enactivism defines participatory sense-making as "the coordination of intentional activity in interaction, whereby individual sense-making processes are affected and new domains of social sensemaking can be generated that were not available to each individual on her own" [21]. Making sense *with and of others* occurs along a participation continuum which involves the experience of dynamically coordinating, negotiating or repairing of meanings in interaction by means of actions, gestures, bodily postures, verbal communication or other multimodal resources. As humans, we engage in participatory forms of sensemaking since birth, when we first start construing our social experience with others in situated, dynamically coordinated ways [20]. As we make sense of the world by moving around in and with it, and coordinate our movements with others in interaction, we literally participate in each other's sense-making activities.

Engaging in participatory sense-making processes may occur within situations of interactional uncertainty, e.g., where an individual's course of actions unexpectedly is halted or changed by someone else's move. To make the interaction moving forward, individuals need to mutually coordinate their actions or moves, even within a very short time frame. Individual sense-making is thus transformed into a participatory effort of making sense of the situation together. De Jaegher and Di Paolo offered an illustrative example of this, imagining two people walking in opposite directions along a narrow corridor.

> "In order to get past each other, they must adopt complementary positions by shifting to the left or to the right. Sometimes the individuals happen to move into mirroring positions at the same time creating a symmetrical coordinated relation. Due to the spatial constraints of the situation, such symmetry favours an ensuing shift into another mirroring position (there are simply not so many more moves available). In this way, coordinated shifts in position sustain a property of the relational dynamics (that of symmetry) that all but compels the interactors to keep facing one another, thus remaining in interaction (despite, or rather thanks to, their efforts to escape from the situation)" [21].

4.2.Participatory sense-making in HRI

Can the notions of engagement and participatory sense-making contribute to expanding our current knowledge and research practice in the field of HRI? We believe so, in (at least) two ways: first, by proposing a new theoretical perspective on how researchers conceive of robots' and humans' participation in social encounters, both from an ontological and a psychological perspective; second, by offering examples of potential situations in which humans and robots may need to negotiate or coordinate meanings while interacting. Both these avenues may prove useful for designing robots capable of participating in real-life situations in smoother and well-coordinated ways. We now present both these arguments. Endorsing a second-person account to interactions implies to see them as social experiences whose meaning can only be understood from the standpoint of those participating in it [19]. In this perspective, interactants' perception of the co-agent (be it a robot or a human) would be informed by their affective experience of the other as a co-interactor; that is, the experience of being acknowledged, responded to and moved emotionally by the other [24, 25, 18]. In a way then, a second-person approach to HRI should be concerned with the question of *what can this engagement* *bring to its participants*? Clearly, here the ontological issue of *what a robot is* to the human's eyes is settling. What definitional criteria should we use to evaluate robots as agents – autonomy, self-consciousness, moral standards? How can we account for the many intersubjective possibilities of engagement with social robots along the "ontological continuum"?[3]

As it was presented above, in the human context participatory sense-making involves coordinating our sense-making activities to achieve social understanding through the joint generation and transformation of meanings in interaction. Endorsing participatory sense-making in HRI would implicate a deep shift in ontological as well as psychological perspective. First, in this view robots are seen as agents whose contribution to the interaction process is as valuable as that of the human. This might lead humans to adapt their social and interactional skills to fit the robot's capacities, and not (as it is usually assumed) the other way around, opening up to new conversational, participatory or self-reflective possibilities and modalities. Importantly, it would mean thinking about design in terms of the joint contribution of robots and humans as participants of equal standing and acting together as a system. Second, and related to the previous point, a more constructivist view in HRI can lead to designing new interaction patterns, taken from real life practices of sense-making in social encounters: exploiting negotiations, misunderstandings, repairs, coordination, or misalignments.

To develop HRI in a more dynamic and fluent direction, perhaps letting pragmatic heuristics guide the interaction, certainly would be a daunting task. People in social robotics long have studied real life interaction for inspiration, but the problem is the technology: Roboticists have not been able to design (build) technology that can interact like humans, e.g., engaging in multimodal communication along several temporal scales during one and the same interaction episode, acting spontaneously while responding adequately to contextual variation. The most popular humanoid robots such as Nao and Pepper cannot be programmed to do this. Technology development is piecemeal. One pertinent question *is what functions are basic to such open and responsive human behaviour that also can be programmed in existing robot platforms*. Another question concerns learning: what algorithms to use and how to increase behavioural complexity. Modelling social interaction by extending models of individual cognition has not been a very successful strategy in advancing human on-line interaction with social robots. Modelling HRI on participatory sense-making would mean abandoning the paradigm of individual cognition as the foundation of HRI and moving from the individual agents to joint action and what individuals are producing together, viz., putting the emphasis on the *relation* and its interaction dynamics. In fact, in recent years we have seen what might be considered a breakthrough in multimodal design in HRI including new touch-based approaches to emotion communication and attempts at modelling the entire social setting of on-going interaction [26, 27, 28].

Additionally, there is a particular aspect of human participatory sense-making processes that we think may be relevant for building better models of interactions with robots: the successful coordination of sense-makers in interaction, be they humans or machines, depends on the specific interactional resources afforded by and to its participants. This means that "although agents can have different individual potentials for entering into an interaction, this potential is not fixed and can be modulated by actual interactions." [1]. Taking the second point seriously would mean putting less emphasis on the general aspects of interaction and more on the aspects that reflect contextual and embedded contributions to the interaction process.

But what does it take for humans and robots to coordinate and negotiate actions and meanings? Imagine the following scene: A robot accompanies an elderly lady to go shopping. After leaving the supermarket, the robot and the elderly lady have to cross a very trafficked road using the zebra crossing. The lady leans on the robot's arm, which slowly guides her towards the zebras until both are almost on the curb. A car is fast approaching and the old woman can only make small steps. The robot must choose what to do. In modelling a human-like decision-making process, the robot might lean its head forward in an attempt to gauge the speed of the car, or to understand if the driver has acknowledged their presence and is intending to stop. In the best scenario, the robot will try to use all available information (the car speed, the lady's walking pace, the drivers' face orientation) to take a decision about what do to. Clearly the driver might as well do the same: try to understand if the two intend to cross or if they will wait for the car to pass over. Most importantly, how this interactive sequence might end up largely depends on the coordination of considerations and actions (meanings) of all actors involved. That is, on a shared effort of making sense of how to go on. The question is then: what kind of technology needs to be implemented to afford social robots the capacity to directly

[3] For participatory sense-making with materials see: Brinck 2018 [29]; for emotional engagement with materials see: Brinck & Reddy 2020 [30].

perceiving their own and other's actions, movements, affective displays and to act accordingly and in coordination with the other? These issues are addressed, for instance, in research on autonomous cars and is key to technology development in the area. Raising the question in the context of HRI stimulates thinking in new directions and will lead to other answers. Some attempts towards simulating shared sense-making situations have been made. To illustrate, Satake et al. [7] developed a technique for pro-active approach and tested it in a series of empirical studies where the robot approached people who were passing through a shopping mall. Once the robot successfully approaches a person, it will identify the person's reaction and provide a timely response by coordinating its body orientation. In comparison to previous simple approaching methods, Satake et al. found that their technique demonstrated a significant improvement in approaching performance, as reflected by the visitors' reactions. Overall, the social situations just sketched can prove to be helpful standpoint to construe a new design pattern in HRI. Implementing and consolidating interactions where humans and robots coordinate or adjust their sense-making can be done to add a new design pattern embedding the ways in which robots and human beings behave in similar situations.

5. Conclusions

We think that Kahn and colleagues' distinction between psychological and ontological claims in the field of HRI as essential to reach a deeper understanding of the interactional dynamics between humans and robots but needs to be understood in a new context. We have suggested that a theoretical shift in how we conceive of social interactions as oriented to the enactivist and second-person approaches will have important implications for both claims, and perhaps show their irreducible interconnection. Our proposal in this article is to extend the landscape of HRI using the concepts of engagement and participatory sense-making as psychological benchmarks and interactive design patterns. Specifically, including participatory sense-making both as a conceptual psychological benchmark and a candidate interactional design pattern may clarify the ontological-psychological continuum. One way to do it is to use micro-observational and ethnomethodological analytical methods [6] to look at how human build up sequentially structured interactions with robots, that is: how each participant's next move is directly connected to the previous moves, and to the incipiently following one. To conclude, and in line with previous suggestions [31, 32], we believe that taking engagement as a starting point for understanding participants' interactional experience with social robots will lead two new insights about the limitations and possibilities of interaction. Research in HRI should take this into account in its future directions. In the end, we might even discover that the valley feels uncanny only for those observing it from the outside.

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