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When a robot is social: Spatial arrangements and multimodal semiotic engagement in the practice of social robotics

Morana Alač
Department of Communication and Science Studies Program, University of California, San Diego, CA, USA

Javier Movellan
Institute for Neural Computation, University of California, San Diego, CA, USA

Fumihide Tanaka
Department of Intelligent Interaction Technologies, University of Tsukuba, Tsukuba, Japan

Abstract
Social roboticists design their robots to function as social agents in interaction with humans and other robots. Although we do not deny that the robot's design features are crucial for attaining this aim, we point to the relevance of spatial organization and coordination between the robot and the humans who interact with it. We recover these interactions through an observational study of a social robotics laboratory and examine them by applying a multimodal interactional analysis to two moments of robotics practice. We describe the vital role of roboticists and of the group of preverbal infants, who are involved in a robot's design activity, and we argue that the robot's social character is intrinsically related to the subtleties of human interactional moves in laboratories of social robotics. This human involvement in the robot's social agency is not simply controlled by individual will. Instead, the human–machine couplings are demanded by the situational dynamics in which the robot is lodged.

Keywords
body, design, gesture, human–robot interaction, laboratory, social agency, social robotics, spatial organization

Corresponding author:
Morana Alač, Department of Communication and Science Studies Program, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0503, USA.
Email: alac@ucsd.edu

How can a technological object such as a robot achieve social agency? This question is of central interest to *social robotics*, one of the recent efforts in *nouvelle artificial intelligence*, which builds robotic technologies designed to engage in social interaction with humans (see, for example, Breazeal, 2002; Brooks et al., 1998; Dautenhahn, 1995, 2007; MacDorman and Ishiguro, 2006; Ishiguro, 2007; Scassellati, 2001; Tanaka et al., 2007).[1] Social robotics deals with the question of social agency primarily by focusing on the robot's physical body; of foremost importance are the robot's appearance, the timing of its movements, and its accompanying computational mechanisms. In this paper, we take up the question and discuss it with respect to interaction in social robotics. Our interest is in describing laboratories of social robotics and attending to what Ludwig Wittgenstein (1953) in his later philosophy calls 'language-games'.[2] By paying attention to how practitioners engage with their robots and each other during their everyday research activities, we suggest that any conception of the robot as an interlocutor must take into account the dynamics of interaction in the laboratory space. Such a conception indicates that the robot's social character extends beyond its physical body, to include multimodal interaction within everyday routines. The robot's social character thus includes its positioning in the space and the arrangement of other actors around it, as well as its interlocutors' talk, prosody, gestures, visual orientation, and facial expressions.

When modeling the robot's social appearance, roboticists name the robot and design its perceivable features to humanize it (DiSalvo et al., 2002). Although they debate whether the robot has to be an android (a particularly accurate replica of a human) or not,[3] they agree that it must share some physical characteristics with humans. A social robot usually has a recognizable torso, hands, head, and so forth. However, attributing social agency and building robots to look like humans differs from sustaining their aliveness and agency in moment-to-moment interaction. Social roboticists and their industry colleagues are discovering that sustaining human interest in a robot is one of their field's most difficult issues. Here we suggest that to deal with this issue one must look well beyond the robot's appearance and built-in control and cognitive architecture. However, we do not mean to consider only the discursive strategies that present the robot as humanlike or to reduce the problem to human predispositions to anthropomorphize the robot. Moreover, we do not believe that an account of a robot's interactions with a single individual would fully resolve the problem. Instead, we claim that a subtle interactional coordination between multiple human actors – including the robot's designers – is crucially important for sustaining human interest in a robot. We further claim that this multiparty interactional coordination allows a technological object to take on social attributes typically reserved for humans.

Research in social robotics does attend to the robot's functioning in everyday settings (Kanda et al., 2004; Tanaka and Movellan, 2006). However, this work has not yet systematically reported on the role of roboticists in these situations. Although social roboticists perform rich experiments that consider pragmatic aspects of human–robot interaction, their reports do not discuss their own involvement in such activities. In this paper, we make that involvement visible, bringing to the fore interactional and material aspects of the roboticists' practice. Following studies of everyday practical action in artificial intelligence (AI), the objective is to 'view the work of designing intelligent machines as a specific form of social practice – a form made more interesting by AI's own concerns with the delegation of social practice to machines' (Suchman and Trigg, 1993: 45). In other words, to understand practices through which scientists and engineers locate human gestures 'in' machines, we explore their gestures in interaction *with* those machines.

We investigate the involvement of designers in the robot's activities by focusing on spatial arrangements and the coordination of embodied semiotic actions[4] (Goodwin, 1994, 2000) in human–technology interaction. But we neither see such spaces simply as physical locales nor as 'subjective' relations between designers and robots (Marantz-Henig, 2007). Instead, we focus on the *contexture of practices* (Lynch, 1991): we are interested in how the robot's animated social characteristics are locally enacted through complexes of action and equipment. The combination of participant observation and video-recording allows us to understand the specific uses of gesture, talk, spatial positioning, and visual orientation in the research situation. We describe where the robot is positioned in space with respect to other objects; the organization of looking practices; and how the robot is implicated in gestures and talk. In considering these aspects of social robotics, we explore the extended network of human labors and affiliated technologies that sustain the robot's functioning (Suchman, 2007). We thus suggest that being social also involves embodied interactions and subtle coordination rooted in the specific temporal and spatial arrangements of the practical situations in which the human-robot encounter is grounded.

Harold Garfinkel's early exercises on the *documentary method of interpretation* (1984 [1967]: Chapter 3) and the observations made about the uses of the AI ELIZA program (Suchman, 1988: 308–311; Weizenbaum, 1976) have indicated that the meaning of action is constituted not by an actor's intentions but through the interpretative activity of recipients. When 'interacting' with a computer program or with a 'counselor'/experimenter who is randomly responding to 'yes' or 'no' questions from an adjoining room, the person uses what she or he has observed to interpret this as representing a presupposed underlying pattern–they see it as an intended event or what the interlocutor must have had in mind (Garfinkel, 1984 [1967]: 95). We explore this line of argument by focusing on human resources that are brought to bear in engaging a nonhuman interlocutor. However, in the case we describe, there is no illusion of human-to-human interaction: the machine is not hidden, and all the actors are physically co-present as they enact the social character of the robot. We are interested in how the embodied subjects together enact the social character of the machine. In other words, we show how the body of the robot is *sustained* through its coordination with the semiotic actions and spatial positioning of its designers.

As we look at groups in interaction, however, our foregrounding of the robot's designers does not imply a return to the *Author* who intentionally organizes the scene. That understanding the robot's social character means one has to look beyond the robot's computational architecture and its human-like appearance and behavior, also means that the social effects of the robot cannot be explained in terms of the designers as demiurgic beings. Instead, the dynamic coordination of spatial and interactional resources in the robot's technological production points to a distribution of agency across multiple participants and spaces. In the case of robot design that we examine here, we see how toddlers that do not yet exhibit ‘full linguistic mastery’ become actively involved in the enactment of the robot’s aliveness and its social character. Thus, rather than controlling the machine, the robot’s designers are called to participate in human–machinic interactional and situational couplings.

In the laboratory of social robotics

To trace the interactional couplings that participate in enacting the robot’s agency, we follow a practice of a robot’s design that is situated in multiple physical locales. The researchers intended to design a robot that would enable them to investigate possible uses of interactive computers in education, specifically targeting toddlers between 18 and 24 months of age.[5] To design such a robot, the researchers worked on the computational architecture while continually updating its current version by immersing the robot in a preschool setting. While at the preschool, the roboticists would consult with teachers and parents and participate in everyday school activities by playing games or singing along with the children. They were interested in gathering feedback from the toddlers and their educators about the design of the RUBI robot.[6] Once back on the university campus, they would modify the robot’s design to take into account what they saw at the preschool. They knew that some of the aspects of the designs were not working, and they wanted to collect information so that they could improve upon it before conducting more controlled studies. In line with their belief that standard laboratory studies were too slow and lacked ecological validity, they tried to speed the feedback loop in repeated visits, while considering ecological validity only to the extent that it would help them develop better robots. When doing so, they did not envision the preschool as the place to ‘test’, ‘try out’, or ‘validate’ a finished design; instead, they used the setting as a ‘workshop’ for continuing to design the robot. The purpose of this iterative process, as pointed out by the laboratory director, was to avoid producing ‘another robot that can only work in the well-defined laboratory settings, and be displayed at public demonstrations’.

The preschool setting where we join the robotics team is called Classroom 1. Classroom 1 is a space in which 2-year-old children can play and learn while their parents are not present. Yet, because the preschool is part of the university, Classroom 1 is also set up as a research space. As depicted in Figure 1, the classroom is divided into three areas, where the two main areas – Area A and Area B – are connected by a door and a big window. The window allows for a direct monitoring between the two spaces. In addition, there is a small room – Area C – which has a one-way screen opening into Area B. During the research sessions when the robotics team comes to the preschool, Classroom 1 remains a space where children can go about their everyday activities while at the same time functioning as a ‘house of experiment’ (Shapin, 1988).[7]

The visits of the robotics team to Classroom 1 provided ethnographic material for examining human–robot interaction. From the material collected from more than 2 years of the study, we discuss here two excerpts that feature different versions of the robot in situations that the roboticists qualify as the ‘robot’s non-functioning’. Such situations reveal aspects that would not be obvious when things work as planned

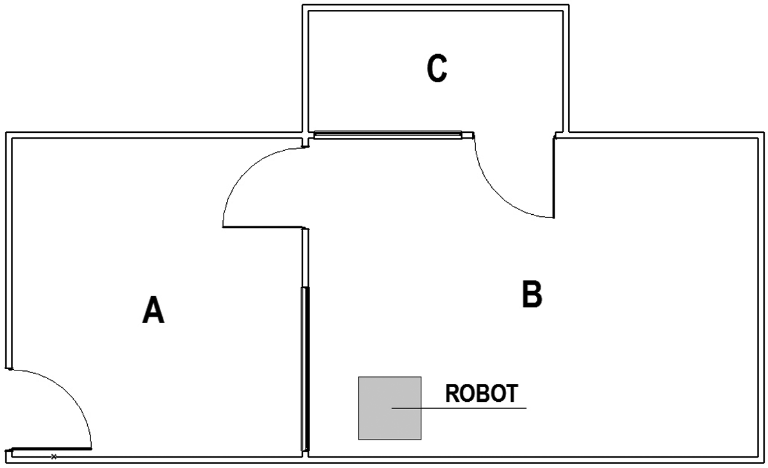

Figure 1. The layout of Classroom 1

(Suchman, 1987), and they also reveal what playing with the robot looks like (we frequently encountered similar situations throughout this study). We pay attention to what takes place when the robot 'fails to work' and to a semi-experimental trial in which the roboticists decided to intentionally tweak the usual setup of the procedure, in a way similar to Garfinkel's (1984 [1967]) 'breaching experiments'. The analysis of the first episode shows how an inanimate robot is animated in a literal manner and through the active participation of the toddlers. The second is an illustration of how the toddlers express indifference toward the robot when the experimenter feigns inattention.

To capture the interactional details of human–technology couplings in these moments, we draw from recent research on the multimodal interactional organization of everyday practices (Goodwin, 1994, 2000; Heath and Hindmarsh, 2002; LeBaron, 2007; Mondada, 2007; Ochs et al., 1996; Streeck, 2009; Suchman, 2000). Adapting this approach for the study of laboratory settings, we transcribed videotaped instances of robotics practice in a way that focuses on gestures, details of talk, visual orientation, and movements of hands. Importantly, we did not treat the videotaped records as complete representations that fully captured the practices of social robotics. Instead, we treated them as an analytical resource (Heath, 1997: 190; Heath and Hindmarsh, 2002: 104) for explicating how the social robot acquires its social agency through interactions with humans. To understand the relevant patterns in the analyzed data, we interpreted the transcribed excerpts in light of the knowledge derived from our long-term participant observation (Cicourel, 1987; Lynch, 1993).

Following Goodwin's (2000) technique of transcribing visual phenomena, we turned still photographs (retrieved from the video) into line drawings (see, for example, Figure 3). We delineated the contours of the participants' bodies and relevant elements of the setting by working directly on the photographs. Our goal was not only to preserve as much complexity of the video record as possible, but also to communicate relevant events as clearly and vividly as possible (Goodwin, 2000: 161).

Figure 2. Robot featured in the first episode

First episode

We join the RUBI team[8] during one of its visits at the preschool after the toddlers had become familiar with the robot. As the team enters the preschool, the ethnographer turns on her camcorder, aiming to capture a complex web of visual orientations and gestures that articulate and are articulated through the activities in Classroom 1.

As shown in Figure 2, the robot was equipped with a computer screen and two cameras that stood for its eyes. The cameras were used to track motions, and its head would move when tracking the movements of a human body. The robot also had a radio-frequency identification (RFID) reader implanted in its right hand to recognize objects handed to it. A touch-sensitive screen was designed as the focus of interaction with the robot. When in 'running' mode, the screen displayed educational games or real-time video of the scenes captured through its cameras. Yet, what happened when the robot was not in the running mode? Did it lose its social agency when the

Figure 3. Susan, Cindy, the teacher, and the PI (from left, clockwise). RUBI robot is on the right

computer screen shut down, with its arms hanging motionless and its eyes unresponsive to movements around it?

We first turn to the details of an episode in Area B, an episode in which the roboticists, after arriving at the preschool, realized that the robot's computers could not be turned on. They quickly agreed that the problem was due to 'power issues' (the robot's batteries had insufficient power to run its two computers) and decided to stop trying to get the robot to function, and instead to use this visit to organize a teaching session to prepare the toddlers for future visits.

When they visited the preschool the previous week, the roboticists were disappointed with the toddlers' performance on a 'give-and-take' task in which they were expected to hand ('give') a toy to the robot when the image of the toy appeared on the computer screen. Each toy has an RFID tag embedded in it to recognize the object when it is placed in the robot's right hand, so when the robot receives ('takes') a toy, the robot – constituted as a distinct social actor who receives the object – thanks the toddler and shows a picture of the toy on its screen. To help improve the game, the principal investigator and the teacher decided to organize the current session as a mock trial during which they familiarized toddlers with the toys and the procedure.

The excerpt opens with the teacher (Te) and principal investigator (PI) sitting on the floor facing each other and busily engaging the two toddlers, Cindy (C) and Susan (S) who are standing next to the them (see Figure 3). The spatial organization, with the participants' bodies facing away from the robot, indicates the participants' attitude toward it: the robot is deemed to be nonfunctioning and thus is treated as of no interest to the group. The excerpt, however, illustrates how the silent conduct of a third toddler – Greg (G) – guides the reconfiguration of the group's activities. By initiating a chain of multiparty actions, Greg significantly affects the robot's change in status. Through interaction, the robot 'co-opts' the human bodies to become an actor of central interest to the entire group.

Each line of the transcript (marked by Arabic numerals 1, 2, 3, …) is divided by the participant contributions – human and nonhuman: PI (principal investigator), R (robot), Te (teacher), and the three toddlers G (Greg), C (Cindy), and S (Susan). The contribution of each participant is further divided in the transcript, which records the name of the participant, line of gaze (g), and line of hand gesture where 'rh' stands for 'right hand' and 'lh' stands for 'left hand'.

The line of talk is transcribed following Jefferson's (2004) conventions:

=	Equal sign indicates no interval between the end of a prior piece of talk and the start of the next piece of talk.
(0.0)	Numbers in parentheses indicate elapsed time in tenths of seconds.
(.)	A dot in parentheses indicates a brief interval within or between utterances.
:::	Colons indicate that the prior syllable is prolonged. The longer the colon row, the longer the prolongation.
–	A dash indicates the sharp cutoff of the prior word or sound.
(guess)	Parentheses indicate that the transcriber is not sure about the words contained therein.
(( ))	Double parentheses contain transcriber's descriptions.
__.,?	Underlining and punctuation marks roughly indicate stress, 'question intonation', and vocal parsing of phrases and utterances.

To transcribe the dynamics of the gaze (the second line), we adopted transcription conventions from Hindmarsh and Heath (2000):

PI, R, T, P, Te	Initials stand for the target of the gaze.
__________	Continuous line indicates the continuity of the gaze direction.

The transcription conventions in the third line are used to depict the hand gesture and are adopted from Schegloff (1984) and Hindmarsh and Heath (2000):

p	indicates point.
o	indicates onset movement that ends up as gesture.
a	indicates acme of gesture, or point of maximum extension.
r	indicates beginning or retraction of limb involved in gesture.
hm	indicates that the limb involved in gesture reaches 'home position' or position from which it departed for gesture.
….	Dots indicate extension in time of previously marked action.
,	Commas indicate that the gesture is moving toward its potential target.

Excerpt 1

1
Te Now let's see let's check on what Javi has got ((while checking the toys in C's and S' hands))
g C and S____

Pl ((picks up the toast toy from the floor while already holding the pizza toy))
g Te____

2
Te ((picks up the toy and gives it to C)) What has Javi got
g ____

Pl ((hands the toast toy))
g ____

3
Pl You like this one? ((hands the pizza toy to Te))
g ____________________________________

4
Te Papa (.) Papa Rubi ((while picking up the toy))

5
Te Uuuu (.) look it's a pizza ((turns the toy toward C and S)) it looks like a pizza but it's not a real pizza (.) looks like a pizza
g C____

G ((comes into the room slowly approaching the Te))
g Te____

Pl
g ____G_____Te_

6
Te Looks like a pizza
g C__________________

G ((halts approx. one meter from the Te))
g __R______________________________

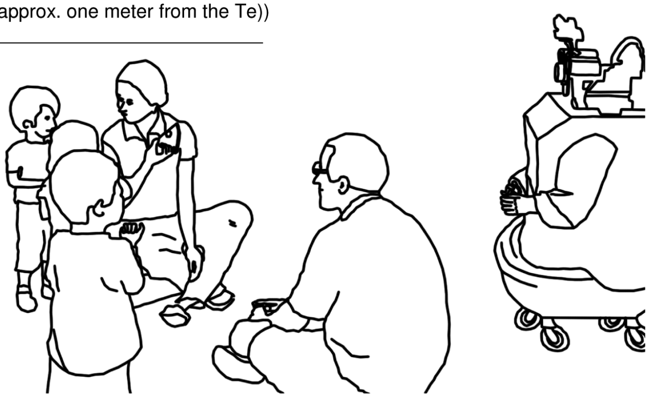

Figure 4.

7
Te What colors do we find in the pizza slice?
g ____
lh ,,p…………………… ,,,,,,p…………..r,,,hm ((points to the pizza toy in her left hand))

G ((walks toward the Te))
g __Te____

8
Te Re:d↑
g _______G_______________________
rh ,,p……..

G ((tries to take the toy from the Te))
g _______________________________

9
Te Did you wanted it, Greg? Greg wanted it? Yeah?
g G____

G ((puts its hands down))
g ____R______

10
Te I'll give it to Ja- Papa Rubi and then ((hands the toy to the PI)) you ask Papa Rubi
g (____)

G ((takes the toy from the PI))
g ____________ R

11
Te Say thank you
g _PI_______________________________________R________

G ((moves toward the R))
g ____

PI Oh he is gonna give it to Rubi
g G_________________________R_______________________G

Figure 5.

12
Te You wanna give it to Mama Rubi?
g ___________________G___________________________________

G
g ____

Pl ((moves the R's right hand with his right hand))
g ___R____________________________________G_______________

13
G ((moves toward the R and puts the toy in its hand))
g ____

Pl ((holds the R's hand))
g _R____

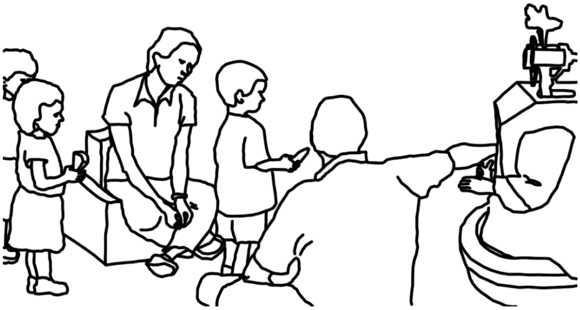

Figure 6.

14
Te Thank you!
g ____________________S________________

G
g ______________________Pl_____ R____

Pl Thank you!
g _____________________G______R__G____

15
Te All right, do you want to give that to Mama Rubi? ((to S who was observing the scene carefully))
g ____
lh ,,p..........................r hm ((points to the toy))

S No: ((while holding tight to the toast toy in her hands))
g R___________________________Te____

G
g ____

Pl ((still moving the R's hand))
g ____

16
Te Just have Mama Rubi touch it
g ____
lh o..a..hm ((gesture as if briefly touching))

S
g ____R___

G
g ____

Pl ((moves the R's head with his right hand))
g _____R____

17
Te Just have Mama Rubi touch it (.) Mama Rubi wants to touch it
g _____________________________C__________________________R__

G
g ____

Pl ((stands up to take a position behind the R))
g ____

18
Te Greg do you wanna Mama Rubi to touch it again? ((while slightly pushing G from behind))
g ____

G
g ____

Pl ((while behind the R starts moving the R's right arm and its head))
g G____

19
Te
g ____

G ((walks toward the R to touch it hand with his right hand))
g ____

Pl ((continues moving the R's right arm and head))
g ____

20
Te Oh look Mama Rubi is smiling

G ((moves backwards toward the Te))
g _____________________________Te______

Pl ((continues moving the R's right arm and head))
g _____________________________________

21
Te Happy face happy face ha ha ha ha

G ((claps his hands))
g ___________R____________________

Pl ((continues moving the R's right arm))
g ________________________________

Where are the boundaries of the robot's body?

At the beginning of the excerpt, the teacher tries to generate the toddlers' interest in the 'toast' and 'pizza' toys. As the toddlers turn toward the toys handled by the teacher and the roboticist, the teacher instructs them on what the toys represent. In line 5, for example, when saying 'Uuuu (.) look it's a pizza it looks like a pizza but it's not a real pizza (.) looks like a pizza' the teacher treats the toy as an especially noticeable thing that stands for something else (Eco, 1976: 7) and whose name should be mastered.[9]

While the semiotic training continues, the group is joined by another toddler, Greg. Greg is older than Cindy and Susan; he recently turned 2 years old and will be leaving the classroom in a couple of days. As Greg makes his way into the group's activity, the spatial organization of the bodies and material objects quickly changes. The excerpt indicates how the 2-year-old, by situating his silent action in the interactional work of the group, manages to redirect the group's attention toward the robot. As the toddler engages the two adults in a series of local moves, he implicates the robot; the robot turns from a nonfunctioning object into an actor in the give-and-take activity. This act of turning an object into an agent is not a metaphoric process but an achievement that involves the materiality of the robot's *body-in-interaction* (Alač, 2009). Through the co-participation of the group's members, the robot talks, while its body moves.

When Greg enters the room, the robot has almost been forgotten behind the PI's back (line 5). Greg first observes the activity of the group (line 5) and then looks toward the robot (line 6, see Figure 4). In line 7, he moves in the direction of the teacher, and in line 8, by putting his hands on the toy in the teacher's hand, he takes the floor. In line 9, while the teacher continues to ask him whether he would like to have the toy, Greg removes his hand from the toy and looks again toward the robot. The teacher, probably understanding Greg's action in terms of an interest in the PI, responds by giving the pizza toy to the PI (line 10). Greg, however, as a remedy to the teacher's comprehension problem, grabs the pizza toy and once again looks at the robot. In line 11, he makes another step toward the robot while ignoring the teacher's plea to say 'Thank you' to the PI (see Figure 5).

The PI, who carefully monitors Greg's moves, quickly modifies his conduct to orient to what the toddler is attending to. As he follows the direction of Greg's looking, the PI extends his upper body to the left, touches the robot's hand, and waves it (line 12). The gesture builds upon Greg's orientation to create a referent of joint attention, and configures the 'nonfunctioning robot' as a potentially active participant in the interaction. Greg can now perform the action deemed desirable when the robot 'works properly': he can give the toy to the robot (see Figure 6). As the toddler does so (line 13), the PI utters in a high-pitched voice: 'Thank you!' (line 14). One could ask: Who is talking? Who is waving the hand? Is the agent the PI (who physically moves the robot's hand, and talks in a high-pitched voice), or is it Greg (upon whose attention orientation and movement through the space the PI built his actions), or the robot?

This hybridization of human flesh, plastic, and wires continues with the teacher's next move. In line 12, the teacher, after asking 'You wanna give it to Mama RUBI?', shadows the PI in line 14 by saying 'Thank you'. The 'Thank you', while assigning the social character to the robot, configures Greg's action in terms of behavior that requires reciprocity: the toddler gives the pizza toy to somebody who shows gratitude in receiving it. In other words, the teacher's actions make Greg's conduct publicly legible in terms of an expected social procedure between two actors where the agency of one of the actors is distributed across human bodies and technology.

In this sense, the scene – what is being said, along with what is done and how all the participants take part in the action – reveals a deep-seated tension. The participation in the recognizable course of action – the give-and-take activity – attributes the agency to single individuals. The teacher and the PI train the toddlers to participate in a procedure in which one individual gives an object to another, who then thanks her or him. But even though the original design of the activity presents the two individuals as independent actors, the interactive sequence undermines this order. The participants' gestures, talk, and actions configure them as multiparty, situated achievements.[10]

For the rest of the session, the PI continues to 'lend' his body to the machine. At the same time, Greg (as well as the two other toddlers – Susan and Cindy) engages in the activity of placing the toys in the robot's hand. Through interactional work and coordination among the toddler and the adults, the 'nonworking' robot now participates as a social actor in a historically shaped activity. In the beginning of the episode, the teacher and the PI considered the body of the robot to be out of play. In organizing the mock 'give-and-take' interaction, the spatial positioning of the two adults excluded the robot from the activity. However, when 2-year-old Greg stepped in and looked toward the robot, he silently initiated a reconfiguration of the activity by steering the group's attention toward the robot's body, which then was brought back to life and assumed a central role in the ongoing activity.

Importantly, however, Greg was not the only actor intentionally reorganizing the scene. His moves were shaped by his coordination with the adults. The adults adapted to the toddler's actions while attempting to enliven Greg's interest in participating in a language game in which the robot is a partner. For example, in line 18 the teacher encourages Greg to approach the robot. When Greg steps forward, the teacher gently pushes the toddler toward the robot. Similarly, when the PI enacts the movements of the robot's hand and head, he produces reciprocal actions to Greg's moves that encourage the toddler to hand the pizza toy to the robot (as expected in the 'give-and-take' activity).

Bringing of the robot to life thus is a locally co-constructed act, in which the robot's animation is achieved through a series of contingent, collaborative moves. The excerpt illustrates how a remedy for the robot's nonfunctioning is performed as a distributed process (Hutchins, 1996) in which the robot's body functions neither as a consequence of its inner mechanism nor in a way predetermined by the roboticists. Rather, the toddler's initiative and the group's collaborative involvement in the situated work and interaction produce the robot's body-in-interaction.

Considering this state of affairs, can we say that the robot's social capacities were out of play (as assumed by the two adults at the beginning of the interactional sequence), and that the instance demonstrates their irrelevance? An affirmative answer to this question would imply that these capacities exist independently of, and prior to, the specific interactions. On the contrary, the preschool episode suggests that the robot's attainment of social agency is grounded in the specificities of the preschool routine. In the situation in which the PI moves the robot's head and arm to receive the toy from Greg (slightly pushed forward by the teacher who, in a high-pitched voice, says 'Thank you'), the toddler is not simply engaging with the two adults, but is also interacting with the robot. The robot thus functions as an interlocutor in the historically shaped interactional dynamics of which it is part.

Body in the practice of social robotics and the puppet (dis)analogy

The set up in which the roboticist literally enlivens the robot's body can be seen as somewhat analogous to a puppet performance. Yet this is not to say that it doesn't matter for this analysis that the ‘other’ is a robot. First, the interaction with the robot has to be understood as importantly shaped by participants’ prior encounters with the robot and by the robot’s computationally specified capacity for coordinated movements. Second, the participants’ conceptualization of the robot – which they bring to this scene from prior encounters – has to be taken into account, as it is particular to the social robot and it would be different for a puppet.

When, at the beginning of the episode, Greg hands the toy to the robot, his action is lodged in a series of prior encounters with the robot and the RUBI team. We believe that the design of the robot – the robot’s physical body and the computational architecture that allows it to respond to the situation in a temporally relevant manner – marks the technological object as a specific kind of actor. Sherry Turkle (2011) has vividly described her involuntary response to Rodney Brook’s Cog robot, as the robot, trained to track the movement of human beings, followed her while she walked with another visitor across Brooks’ laboratory:

> At one point, I felt sure that Cog’s eyes had ‘caught’ my own, and I experienced a sense of triumph. It was noticing *me*, not its other guest. My visit left me surprised – not so much by what Cog was able to accomplish, but by my own reaction to it. For years, whenever I had heard Brooks speak about his robotic ‘creatures,’ I had always been careful to mentally put quotation marks around the word. But now, with Cog, I had an experience in which the quotation marks disappeared. There I stood in the presence of a robot and I wanted it to favor me. My response was involuntary, I am tempted to say visceral. Cog had a face, it made eye contact, and it followed my movements. With these three simple elements in play, although I knew Cog to be a machine, I had to fight my instinct to react to ‘him’ as a person. (Turkle, 2011: 84)

During our visits to the preschool we regularly observed toddlers responding to robot’s movements in the manner described by Sherry Turkle. These responses have to be taken in account when understanding the described scene, as they shape the local actions.

Moreover, it should be remembered that in social robotics the goal is to design an independent, self-sufficient creature. This is somewhat different from puppet theater where the presence of the puppeteers can be rendered visible. For example, in the introduction of his *Toward and Aesthetics of the Puppet*, Steve Tillis (1992) generates a sense of the vast range of puppet-performances by providing the reader with vignettes from Nigeria, Java, UK, USA, India, and Japan. It is interesting that the expositions of three of these examples – the Javanese, American, and Japanese – indicate that the audience during the performances sees that human performers give movement and speech to the puppets (Tillis, 1992: 2–4). Even through the overt presence of the puppeteer on the stage is more rare than not, it does point out the intentional link between the human operator and puppet as a central feature in the way the puppet is framed.[11] Tills explains that:

> In much puppetry … the operator and/or speaker is not present on-stage, and yet the puppet is perceived to be an intentional creation subjected to intentional control. Even when the puppet is presented in the most imitative manner possible, it is perceived by its audience to be an object. … (E)ven when the operator and/or speaker is present on-stage, and the puppet is obviously an intentional creation subjected to intentional control, it is still imagined by the audience to have a spurious life. (Tillis, 1992: 159)

In social robotics, on the contrary, the roboticists do not want to show themselves as agents who are directing the robot (at least not synchronously). At the preschool, for example, when the researchers directed the robot from Area C (while monitoring the happenings in Area B through a one-way screen opening), they stayed carefully concealed, and we never observed them reveal their doings at the end of the session.[12] Thus, even though the PI during the first episode ends up taking a role that is rather similar to a puppeteer, this arrangement of bodies and technologies is not determined intentionally and before the encounter, but it is a feature of interaction.

Second episode

The robotics team was wary of potential criticisms that the preschool environment is too complex for a rigorous study of the robot's functioning. Because of the number of variables that characterize this environment, every attempt to evaluate the robot's functioning may be 'contaminated' by environmental effects. To respond to this type of criticism, the team decided to set up an intervention session in which they would control such variables by not engaging in the interaction with the toddlers.

The intervention was set up so that the PI was seated on a rocking chair in Area B while pretending to read a children's book (later, the PI will be joined by three toddlers: Philana, Tansy, and Cary), and was surrounded by two almost identical robots placed on the floor (Figure 8). One of these industrially manufactured robots that are smaller in size and highly mobile (see Figure 7) was configured to be remote-controlled (from Area C, see Figure 1) so that it could emit giggling sounds in response to toddlers' actions. The other robot – envisioned as an experimental control – was left completely stationary. During the intervention, even though the practitioners had decided not to interfere in the encounters between the toddlers and the robot, the PI positioned himself adjacent to the robots. He did so to guarantee the safety of the toddlers and to maintain comparability with the previous sessions (during which he interacted with the toddlers as they engaged the robot). One of Erving Goffman's (1971: 38) *territories of the self* is *possessional territory*, where the actor marks her or his territory by placing a set of objects or visibly co-present associates around her or his body. In this case, the positioning of the PI and the robots marks the robot's possessional association with and dependence on the PI.[13]

The video record of the intervention shows that the toddlers took immediate interest in the scene. As soon as they enter the Area B, they approach the PI, pointing at the robot while uttering excited bids to get the PI to elaborate on what they see. In Figure 9A, for example, Philana first enters the room, moves directly toward the robot, and points at it. At the same time she looks toward the PI and further bids for his attention by emitting an excited 'Ah'. Philana, like other children from the preschool, apparently is keying into a previously established interactional routine in which the PI acknowledges her attempts to draw his attention toward the robot so that he can then show her what to do with it in the situation.

However, Philana's effort is frustrated. The PI, acting in a 'neutral manner', refrains from responding to the toddler's initiation of 'show-actions' (Kidwell and Zimmerman, 2006, 2007). While Philana points toward the robot and says 'Look' (Figure 9B), the PI looks at the book, indicating that he is unwilling to follow up and show her how to interact with the robot. The PI's deliberate restraint here does not, however, cover all responses

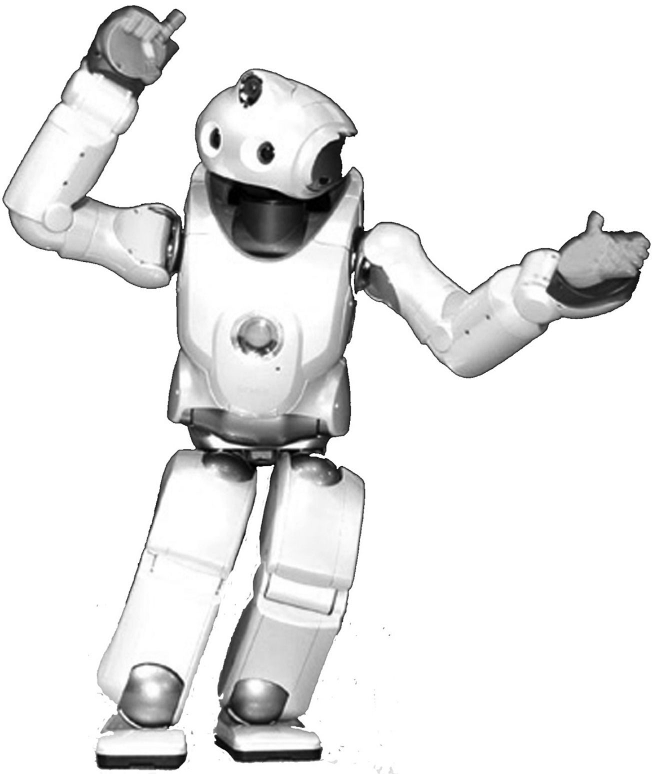

Figure 7. One of the two identical robots featured in the second episode

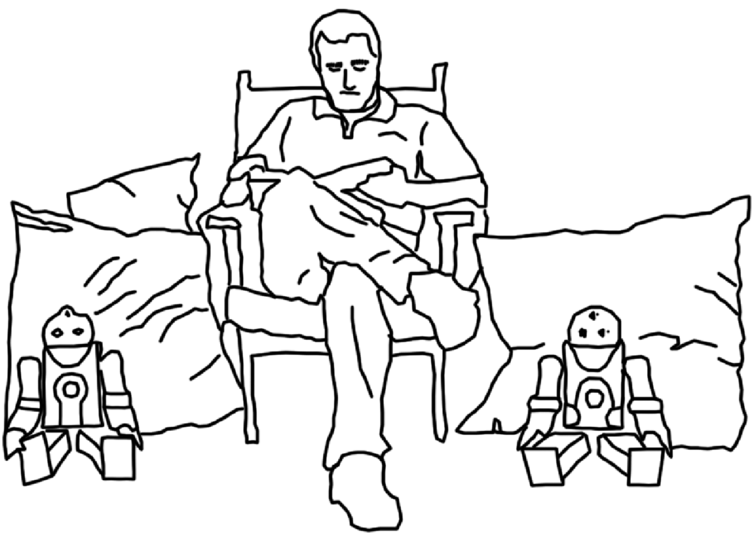

Figure 8. The PI with two robots, one at each side

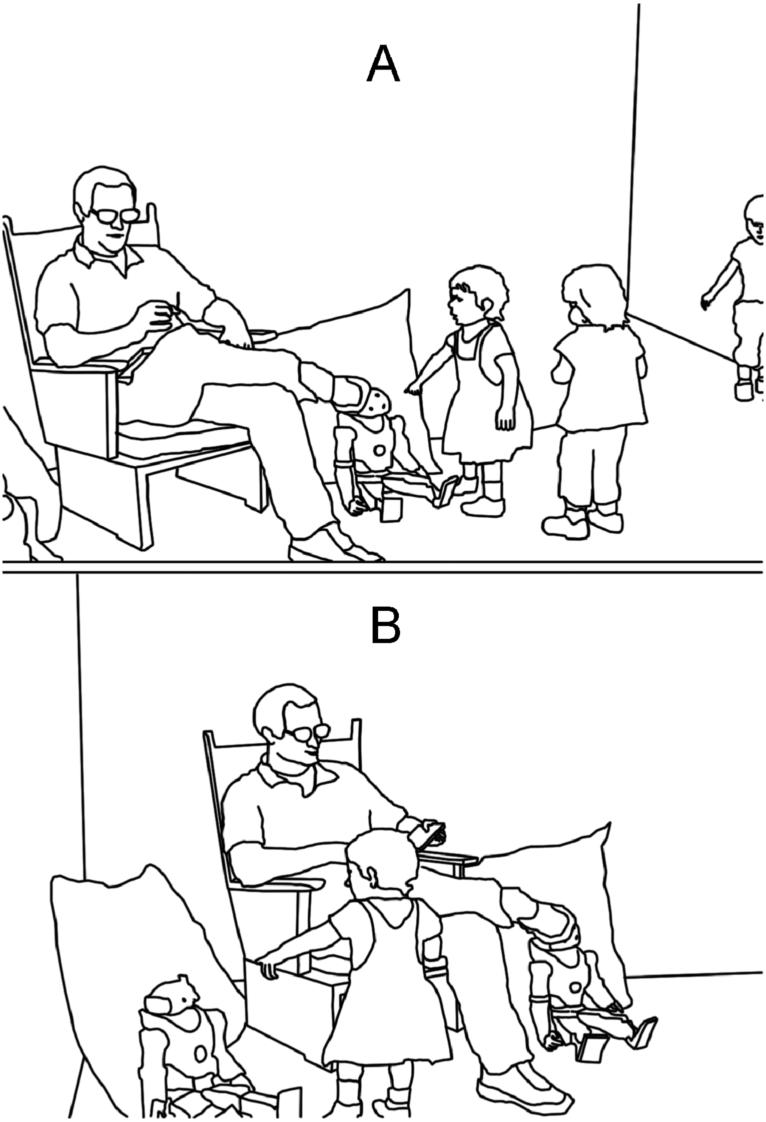

Figure 9. Philana points to the robot while the PI enacts a neutral stance

to the toddler's conduct. For instance, his smile (see Figure 9B) and his acknowledging of the toys that the toddlers are showing (a fly, a car, a ball, and books) shows that he selectively picks up on some aspects of the situation, even while he refrains from responding to the toddlers' interest in the robot.

These efforts to ignore the robot juxtapose two contrary modes of expression: while Philana and the other toddlers excitedly try to get the PI to co-participate in the routine, he responds with indifference. As the activity proceeds, the PI minimizes his references to the robot, and when he does refer to it, he uses a monotonous voice. At one point, he even explicitly corrects the teacher when she joins the toddlers' engagement with the robots. This refusal to reciprocate the toddlers' excited attentions to the robot generates awkward interaction between the toddlers and the roboticists.

As the interaction develops, the toddlers begin to treat the PI's refusal to join the routine with the robots as itself a move in another language game, which we can call the 'ignoring game'. They progressively minimize the attention they devote to the robots, while at the same time they exhibit more and more involvement with other activities. When one of the robots moves (directed by the operator located in Area C), the movement provokes the toddlers' curiosity. Yet, as a part of the 'ignoring game' developed in reaction to the adults' apparent disinterest in the robot, they conspicuously disregard it and eventually abandon Area B.[14]

Coordinating the public acts of ignoring the robot

The following excerpt illustrates how the 'ignoring game' is managed through interaction. At this point in time, the PI has changed his seating position to place himself on the floor, just in front of the two robots (as shown in Figures 10 and 11). As he focuses on the open book he holds on his knees, the PI is surrounded by two toddlers: Tansy (T) and Cary (C).

Excerpt 2

1
T ((enters the Space B running, and throws a ball))
g PI___

PI
g R____

R ((moves its torso and legs))

2
T ((walks forward to pick up the ball))
g R_______PI__ PI___R___________

PI
g _____T________R__________T_________R______________

R ((moves))

3
T ((walks toward the PI and throws the ball just next to him))
g PI______________________________________

PI
g ______T____

4
T
g ______________________________R___________

PI ((picks up the ball)) Thank you! ((leans toward the robot while holding the ball))
g R____

R ((moves))

5
T
g ____

PI
g T___ R____C____

R ((moves))

C ((walks in from behind the PI toward the robot))
g R

6
T
g ____

PI
g ________

R Ha-ha-ha

C ((turns around and walks back. When behind the PI stops))
g _____ R____

7
T ((runs toward the robot))
g ____
PI
g T___________________R
R
C
g ____

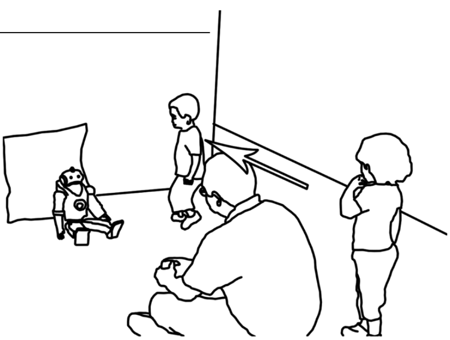

Figure 10.

8
T ((turns around and walks back))
g PI____ R

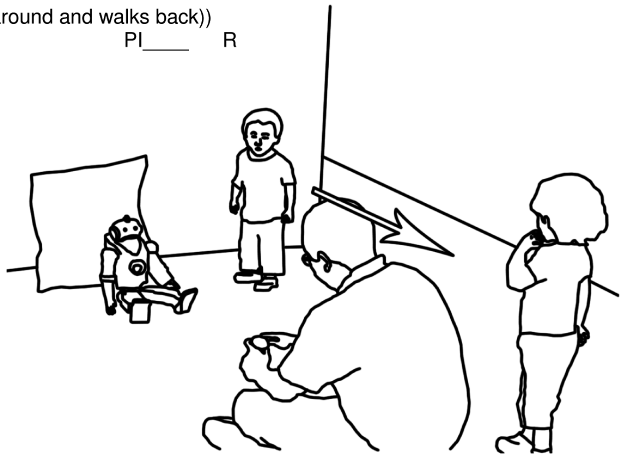

Figure 11.

PI
g __ T____ C____________
R
g T_________C__ PI
C ((leaves the space running))
g ____

The excerpt shows the toddlers engaged in playing with the ball (lines 1, 3), running with their heads up (line 8), and performing exaggerated, dance-like movements (line 8), while they, at the same time, systematically avoid looking at the robot. These actions conspicuously orient to other objects and activities in the room, in an apparent effort to get the PI to attend to their moves and approve of their actions.

Even though Tansy has already learned that the robot should be ignored, the movements of the machine and the direction of the PI's gaze draw her attention to the robot (she is captivated by the robot's movements, much in the way Sherry Turkle says she was during her encounter with Cog). In lines 1, 2, 4, 5, 6, 7, and 8, Tansy looks at the robot when it moves, and the timing of her looking coincides with that of the PI. The PI turns toward her (lines 2 and 5), but he never comments on the robot or affirms the toddler's interest in it.

In response to this type of situation, where both participants react to a change in the robot's state but do not follow up with an interactional routine, Tansy's glance toward the robot tends to be brief (for example, lines 2 and 8). It appears that she cannot help but look at the robot, but then downplays her curiosity. The only point where she looks at the robot for a longer period of time takes place in lines 4–7. This longer glancing occurs just after the PI, who is looking toward the robot, cheerfully thanks her for the ball (line 4).

Cary's conduct is also interesting. Cary joins the activity in line 4, but shortly after approaching the robot, she takes a position behind the PI's back (see Figure 10), which allows her to look at the robot and observe the events in Area B while being screened from the PI's line of sight (lines 6 and 7). 'Concealed from the superiors' (Laub Coser, 1961) she apparently conforms to what is expected in Area B while still being able to watch what is of immediate interest to her. When Cary leaves the room in a hurry (line 8), she steadily looks at the door, performing the 'ignoring'.

As the toddlers parse the action and orient to the environment, while picking up how to act in the scene from the adults, they learn, paradoxically, to display their interest in the 'game' at hand by not displaying any interest toward the robot. They thus show a competence with treating *not* looking, as well as directed looking, as concerted actions in the game. Therefore, what is at stake is not simply a lack of shared attention, but a shared avoidance of visibly attending to the robot. This leads to a cessation of any interest in the robot, as the toddlers abandon the scene.

In an interview after the session, the practitioners expressed their frustration. As explained by the PI, the goal was to 'act neutral'. The attempt, however, took an unexpected turn. The procedure created a situation in which the practitioners and toddlers felt 'uncomfortable' and 'strange', and it indicated that the 'cleaning of the social' was impossible. The practitioners noticed that what they were doing was not 'cleaning' confounding social elements from the interaction. Rather, it involved 'doing' a different type of interaction in which they guided the toddlers to adopt the 'ignoring stance' toward the robot. The PI said that their nonintervention was itself an intervention, which made them feel uncomfortable, as they were inhibiting the habitual richness of the interactions in which they participated. Akin to the famed 'breaching experiments' (Garfinkel, 1984 [1967]), devised to disrupt commonly accepted social conduct in order to expose the taken-for-granted ordering of such conduct, the team, rather than 'non-participating', was participating in an unacceptable way. In fact, after this session, it took a rather long time for the roboticists to muster the energy to go back to the preschool.

The session did, however, have a significant relevance for the project. It showed that by inhibiting the communicative routines that are usually being called upon at the preschool (such as exclamations of excitement, utterances that direct attention, positive assessments, invitations to look, and the willingness to act upon the invitations), the participants' interest in the robot fades. After a while, each of the participants settles in an activity that keeps him or her busy somewhere else (as the patterns of action no longer involve the robot).

The incident also indicated something about the robot's social character: that the robot is not treated as a social creature in the absence of coordinated interactional practices. The robot and its movements are interesting – they immediately capture attention. Yet, that attention is part of coordinated sequences of social interaction that take place and recur in specifically organized settings – here the preschool. Despite the fact that the robot did move 'from within' on this occasion, it could not sustain the toddlers' interest without the practitioners' willingness to engage in what is considered to be an appropriate social interaction. This suggests that the robot's social character is critically relative to the human interactional dynamics and situational arrangements in which it is lodged. Without the social involvement that goes beyond the interaction between a single individual and the robot, the 'social' seemed to lose its social character. Even if the robot's movements momentarily attracted attention, their curiosity was only sustained through the locally developed interactional infrastructure.

Social robots, dogs, and candy bars

Social roboticists construe their machines as technologies with the potential to function as self-standing objects that can display agency and social character, so they often compare their robots with pets rather than hammers and door closers. A recent study, widely featured in mass media outlets,[15] entitled 'Animal-assisted therapy and loneliness in nursing homes: use of robotic vs. living dogs' (Banks et al., 2008), argued that a robotic dog (that is, Sony's AIBO) was just as effective as a live dog was for decreasing loneliness among elderly patients in a long-term care facility (in comparison with a control group that did not receive animal-assisted therapy). In the study on robotic dogs, however, descriptions of the visits to the nursing home with AIBO and the real dog were highly generalized, leaving out the interactional detail.[16] In fact, social roboticist Sara Kiesler critically remarked: 'The problem is inferring it was the robotic dog that reduced the loneliness, and not the human who brought him into the room.' She suggested that 'another study could compare a visit from AIBO with someone stopping by with a stuffed animal or even just a candy bar' (Kiesler, quoted in AP, 2008).

Similar to Kiesler's concerns about the effect of the person who brings the robotic object to the elderly, we highlight the role of roboticists in the functioning of the social robots. Our argument, nevertheless, differs significantly from Kiesler's claim. Whereas Kiesler proposes to control and potentially quantify interactional effects (suggesting that the effect of the robot needs to be measured in comparison with other objects), we focus on how the robot is part of a larger interactional framework. We suggest that situated interactional work is material to the robot's functioning. If, for example, we were to substitute a toy or a candy bar for the robot (as Kiesler suggests), we would not simply be controlling for a discrete effect on the human subjects. The problem is that the substitution would significantly change the situational dynamics. The person bringing a toy or a candy bar would orient differently to the object than she or he would to the robot. As the preschool interactions testify, when the robot is engaged in interaction, it is treated as a social agent, which probably would not be the case if the object of interest were a candy bar.[17]

In Excerpt 1, for example, when the teacher and the PI use the toys to prepare the toddlers for the participation in the give-and-take game, even though they position the toys at the center of the group's attention, they organize the attention around the toys differently than they do when engaging with the robot. When one of the toddlers – Greg – initiated the action that drove the reorganization of the patterns of activity in Area B, the adults not only felt compelled to step in and enable the toddler to engage with the robot, but they also directed their attention toward the robot by looking at its face, expressing emotion, and, more generally, treating the robot as a social actor. In other words, once they orient to the robot, they treat it as a subject rather than an object.

Excerpt 2 illustrated how, consequently, the denial of this social uptake generates significant consequences. When the practitioners attempt to control for their impact on the toddlers' encounter with the robot, they nonetheless position themselves next to the robots, marking a relationship with them. Thus, when the children enter the room, they immediately attend to this arrangement, as the organization of the setting evokes the already established and collectively relevant background. Next, when the toddlers move toward the robot but apparently fail to elicit the adults' attention (as the PI chooses systematically not to respond to their moves), the situation generates discomfort and extinguishes the robot's social character.

This indicates that the robot, situated in particular material and social circumstances, is importantly configured as a social kind of entity through spatial organization and the employment of multimodal interactional resources. It also suggests that the sensitivity of the robotic object to interactional dynamics is a characteristic of that object. When the toddlers enter the area where the robot is stationed, they find the setting organized for specific looking practices. Although they do not see who is behind the one-way mirror directing the robot's movements, they encounter the roboticists in the room as available for interaction and associated with the robot. The process of reorganization of the site of knowledge and the embodied participation in the production of the robotic technology generate effects on how the robot is approached and dealt with. The robot displays agency not as a self-standing object but in interaction.[18]

How about the comparison between social robots and pets, so dear to social roboticists? Is the treatment of the robot as a social entity in some way analogous to our treatment of dogs as pets? It is interesting to note that, much like our account of the social robot, recent work in animal studies has pointed out the importance of relationship and relating. Donna Haraway (2008) suggests that 'actors become who they are in *the dance of relating*, not from scratch, not ex nihilo, but full of the patterns of their sometimes-joined, sometimes-separate heritages both before and lateral to *this* encounter' (2008: 25). In her *The Companion Species Manifesto* (2003), Haraway discusses this idea in connection with a popular book by dog and horse trainer Vicki Hearne, *Adam's Task* (1986). Haraway explains that:

> '[M]ethod' is not what matters most among companion species; 'communication' across irreducible difference is what matters. Situated partial connection is what matters; the resultant dogs and humans emerge together in that game of cat's cradle. Respect is the name of the game. Good trainers practice the discipline of companion species relating under the sign of significant otherness. (Haraway, 2003: 49)[19]

Whereas Haraway's and Hearne's writings do not offer embodied and lived detail of how these acts of relating actually happen in practice, we learn this from David Goode's studies of human–dog play (2007).[20] Goode describes how dogs and humans understand and define each other reciprocally through the moments of their everyday action and interaction. This turn toward the mundane, embodied specificities of how the relations are achieved as praxiological matters allows Goode to ground the psychology of participants in practices that compose recurrent events. By describing the players' mutual movements, and their posturing in relation to the play objects, meaningfully embedded in the unfolding course of action, Goode deals with 'inner states' as observable matters to players (Goode, 2007: 59):

> We rely upon the movements of the animal, natural to the animal, as expressions of the animal's intentionality-in-action. The movements are read against a backdrop of understanding what the game is, and what the animal is trying to do, what game move it is making, then and there. … However, … this form of understanding is not anthropomorphic projection of one's own mental state but, rather, witnessed intentionality-in-action. (Goode, 2007: 75)

In the current study, as we worked with the idea of observing intentionality and social agency in embodied actions,[21] we went beyond the actions of the robot's physical body to show how the robot also features as a social actor when *not functioning*. In doing so, we specifically turned to the everyday work of design and the role of the roboticists. By describing the activities at the preschool, we pointed out how the robot is treated as a living, social creature even when its body does not move by itself (First episode). In light of the previous occasions at the preschool, the participants in the scene organized the interaction so that their own conduct and their own employment of semiotic resources turned what was judged to be a nonfunctioning technology into an agent that participates in the give-and-take game (First episode). This example was contrasted with the scene (Second episode) where the robot does move but does not attract sustained interest, since the social uptake around it is missing.

Thus, by describing the linkages between humans and nonhumans in social robotics, as proponents of animal studies do in their work, we indicated the relevance of relational understanding. At the preschool, the agency of the robot is enacted through unfolding courses of interaction that engross the toddlers and roboticists. There, the intentionality of the robot is observable in action, yet is generated not only through the movements of the robot's physical body, but also through the coordinated multimodal interaction of the robot with humans who engage with it. However, despite this apparent resemblance between the understanding of pets and social robots, we argue in favor of distinguishing between the two realms. Companion species and social robots have different stories to tell about their relationship with humans, since they are characterized by their own evolutionary trajectories, histories, temporalities, matarialities, actions, and embodied practices.

Hearne, for example, distinguishes training animals that have a working temperament from training non-domestic animals, as she keeps in mind evolutionary and biological forces (Hearne, 1986: Chapter 2), and Haraway carefully traces the history and development of Great Pyrenees and Australian Shepherds breeds, discussing the problems of ecology and genetic diversity (Haraway, 2003; Haraway, 2008: Chapters 4, 5). On the other hand, understanding the social robot's specificity requires a careful look at the details of the everyday in the laboratory.[22] While robots come with a cultural and historical baggage (see Adam, 1998, Riskin, 2003), they are also shaped through their manufacture. In other words, when talking about social robots, at stake are the processes of design and designing in laboratories of social robotics. In paying attention to design activities (in an 'extended' laboratory of social robotics), we showed that the robot's social character (and, thus, its potential to maintain interest over time) needs its designers. Designers' gestures, talk, and actions participate in the robot's social character. The social character of the machine does not reside only in its physical body, but it needs the laboratory where objects and people, with their interests and knowledge, have to be skillfully coordinated.[22]

Designers, local arrangements, and the multiparty coordination in the laboratory of social robotics

Steven Shapin (1988), when discussing Robert Boyle's 17th century natural-science laboratory in England, drew attention to the importance of the physical site for knowledge production. Shapin points to the well-defined threshold between public and private, when describing who was in attendance and therefore had sensory access and the ability to testify to experimental phenomena. Here, we used this idea, but also drew upon Michael Lynch's (1991) argument that the place of scientific work goes beyond the physical setting, and includes the locally organized topical contextures associated with distinct practices and equipment. In our examples, these topical contextures concern a laboratory space with extended boundaries. Because the roboticists want their robot to be designed through its immersion in a real-world setting – the preschool, a place where toddlers learn and play – that workplace also functions as a part of their laboratory. In this sense the laboratory itself is an outgrowth of other organized places,[24] while the preschool functions as a laboratory because it is constituted by the performance of experiments: at the preschool, instruments and people have to be skillfully arranged to make the phenomena of interest observable (for example, Lynch, 1985).

In his essay 'Give me a laboratory and I will raise the world', Bruno Latour (1983) addresses criticisms that microstudies of scientific laboratories fail to account for 'larger problems' (typically analyzed by researchers interested in institutions, organization, and policy). Using Louis Pasteur's laboratory as his example, Latour describes how Pasteur becomes a 'macro-actor' by extending the laboratory to the field (the farm) and then moving back into the laboratory, where scientists develop a new mastery of novel material (1983: 149). When he returns to the farm, Pasteur 'repeats' what was done in the laboratory (1983: 151). In other words, he selectively extends the laboratory regime into the farm, and tries out his laboratory innovations in a new set of conditions that either invalidate or verify the efficacy of those innovations. Like Latour's account, our treatment of social robotics refrains from making any clear-cut distinction between the inside and outside. However, contra Latour's Pasteur, the university laboratory doesn't simply 'extend' into the preschool, because routines that are worked-out in the preschool by the researchers and their robots build upon interactional 'games' played there already. In this light, we described how an attempt to impose a laboratory type of control over the situation ignores the ongoing routines and leads to a confounded situation. The events at the preschool thus transform the university laboratory, as they disturb the social roboticists' preconceptions about what it means to be a social actor.

This focus on the laboratory space as a co-articulation between the university laboratory and the preschool allowed us to indicate the centrality of interactions for enacting the robot's social agency. By analyzing the two preschool episodes, we indicated that the robot's social agency is importantly an achievement in which the roboticists play a key role. This, however, does not mean that roboticists are somehow directing the robot. We have often heard remarks that compare social roboticists with magicians and theater directors, 'since they know the "tricks" behind the technology'. Instead, we showed that the flow of the interaction, rather than being determined in a top-down fashion, is a process of participation and co-construction, where the toddlers play significant roles. In fact, when we talked about the structures of directing the collective, public attention toward the robot, we did not want to imply that the toddlers performed only what they were told to do, but we indicated how the articulation of the robot's social character relied on actions that were readable by other co-participants.

If we were to understand the PI's interactional moves as a manipulation that made the toddlers' actions appear as part of a coherent series of expressions that implicate an animate other,[25] this kind of interpretation would miss some of the essential features of the interaction. First, it would privilege the linguistic performance over the multimodal interaction that characterizes the toddlers' conduct. By erasing the toddlers' positioning, visual orientation, their gestures, and their vocalizations, it would make them out to be passive. What is more, this interpretation would not take into account the trajectory of interaction, where the PI's conduct is shaped by the toddler's presence in the room. In other words, the PI cannot choose to be blind to everyday practical experience; rather, his actions are continually sensitive to the intersubjective life-world that he and the toddlers together create and inhabit. Finally, this interpretation would overlook the PI's overreaching goal, which is not to show that the toddlers treat the robot as an interactant (if this was the goal, the PI would probably perform a controlled laboratory experiment), but to observe how the toddlers respond to the robot in their everyday setting so that he and his team can improve on the robot's design.

Taking account of this mutual engagement is important, so that the robot's social character is not dismissed as a 'mere construction'. The idea that the robot's social agency is constructed would assume that the boundaries between the robot's body and the bodies of the actors who engage with it were established in advance: the designers would feature as human individuals who engage in a process of constructing the robot's agency, while the social character of the robot would become an epiphenomenon. We claim instead that the robot is in fact social, but its social character does not exclusively reside inside the boundaries of its physical body or in its programming (see also Alač, 2009). As the roboticists, toddlers, and their teachers engage in the design practice, the robot becomes a social creature in and through the interactional routines performed in the 'extended' laboratory.

Would this also be the case if we were to observe the design of a social robot when this process is confined to the boundaries of a university laboratory? Could we claim that in the university laboratory (or any other traditionally confined space of research) the robot's social character is importantly embedded in the work, experimentation, affection, and responsibilities enacted at the level of gestures, talk, visual orientation, and expressions of emotion? Yes, we believe so. The robot's social character would be importantly enacted through its engagement with roboticists.[26] Nevertheless, our examples from the extended laboratory were the focus here since they not only indicate the linkage between the robot and its designers, but they also demonstrate that the robot is not under the absolute control of the roboticist. Since we did not want to reduce this linkage to psychological or individual states of the roboticists, we chose examples from the preschool to show how, when enacting the social character of the robot, the roboticists respond to the complex interactional trajectories often initiated by the toddlers. In the presence of the robot and other human actors, the roboticists are interactionally implicated in (rather than intentionally organizing) the robot's social character.

Finally, it could be argued that when the robots leave the laboratory, they will act with autonomy, devoid of any link to their designers. Although we like to leave this open as a future possibility, we call attention to the present situation where these scenarios are still largely imaginary. Because robots are currently showing their aptitudes in public demonstrations and in laboratory settings (which are often 'hybrid' in their character, as described in this paper), it is imperative to witness the work that takes place in these environments. Similarly, even though we do not want to imply that our understanding of how designers interact with their robots informs us about how 'people, in general' or 'users' *will* interact with social robots, we are convinced that any understanding of the interactions outside of the laboratory must first take into account the work of designing these robots. This work indicates that the robots become legible as social actors in relation to careful interactional engagements and the spatial arrangements of people and things.

Notes

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1. Social robotics treats these technologies as potentially valuable tools for understanding embodied and multimodal aspects of human communication and interaction (Otero et al., 2006; Sakamoto et al., 2005) while aiming at their use in fields as diverse as tourism, mass media, health services, and education.
2. 'Here the term "language-game" is meant to bring into prominence the fact that the speaking of language is part of an activity, or of a life-form' (Wittgenstein, 1953: §23).
3. See discussions on the problem of the 'uncanny valley' (MacDorman and Ishiguro, 2006; Mori, 1970).
4. 'Semiotic' should not be reduced to 'symbolic'. As proposed in the philosophy of Charles Sanders Peirce, semiotics has to do with phenomenological aspects of communication and interaction. According to Peirce's (1867: CP 1.545–1.559) phenomenology, every experienceable entity possesses the properties of *firstness* (as a phenomenal entity in itself), *secondness* (as it stands in dyadic relationships with other entities), and *thirdness* (as it stands in triadic relationships with other entities) (also see, for example, Ransdell, 1989; Rosensohn, 1974). Based on this distinction, Peirce builds his semiotics with his well-known distinction between *symbol*, *index*, and *icon* (the distinction is based in the relationship that the sign has with the object it signifies). This understanding has a pragmatic character, as Peirce's signs gain their meanings through their concatenation or *semiosis*, which is a time-bound, context sensitive, interpreter-dependent, and materially extended dynamic process (Queiroz and Merell, 2006). Peirce's view of semiotics bears affinity with Wittgenstein's (1953) later philosophy (see, for example, Crocker, 1998), unlike the *structuralist* semiotics in the tradition of Ferdinand de Saussure (see Høstaker, 2005; Lenoir, 1994), which is more prevalent in science studies. We adopt Peirce's semiotics in this paper to talk about 'embodied' and 'multimodal' interaction, and to signal that not only language tokens, but also gestures, non-linguistic vocalizations, visual orientations and movements participate in accomplishing actions in specific practical circumstances.
5. Children who do not yet exhibit 'full linguistic mastery' are of particular interest to the researchers because, in line with the social robotics aims, they provide a window on the embodied aspects of cognition and interaction. Toddlers at that age are able to follow gaze, point, and engage in joint attention (see, for example, Baron-Cohen, 1991; Butterworth, 1991; Tomasello, 2003; Wellman, 1993).

6. RUBI is an acronym that stands for 'Robot Using Bayesian Inference' (Movellan et al., 2007).
7. There is a tradition of converting classrooms into laboratories, with one-way mirrors, video cameras, and seating arrangements that optimize observation (Bailey et al., 1970; Kent et al., 1979). The contained and controlled space of the classroom lends itself to such use, and concerns about the effectiveness of classroom education provide incentive (Cromwell, 2002). A similar kind of arrangement also is present in medical settings, where surgical theaters (Hirschauer, 1991) are both places of work and places of observation – where 'observation' is part of the pedagogy (Prentice, 2007).
8. The team usually consists of one or two researchers (the second and the third authors of this paper), two to three PhD students from the laboratory who are pursuing studies in computer science and cognitive science, and an ethnographer (the first author of this paper).
9. In the course of the naming activity, the Te assigns a nickname to the PI. While talking to the toddlers about the PI, she switches from 'Javi' in lines 1 and 2 to 'Papa RUBI' in line 4. Again in line 10, she initiates her utterance by saying 'Ja' to then repair it in 'Papa RUBI'. As the Te discursively positions the practitioner in the role of the robot's spouse, she assigns a human character to the robot.
10. For a discussion of the robot as a multiparty interactional achievement, see also Alač (2009).
11. In some conceptions this link is also bidirectional, see also, for example, Bogatyrev (2001 [1923]: 89–90).
12. This understanding of the robot vs puppet can also be traced to the idiomatic expressions in the English language. We may, for example, call somebody a puppet in reference to actions of theirs that had been prompted and controlled by others. On the other hand, when we call somebody or something a robot, we tend to highlight their automatic or mechanical, but autonomous performance.
13. In this sense, the seating position generates similar effects to those produced by the expression 'Papa RUBI', encountered in Excerpt 2.
14. This dynamic is somewhat similar to the interaction between the toddlers and the ethnographer. The toddlers quickly learned that the ethnographer, shielded by her video camera, would not participate in the activities around the robots. During this visit to the preschool, the videotapes indicate a couple of instances in which the toddlers look toward the ethnographer (after they did not receive an expected response from the PI). Nevertheless, there is no record of the ethnographer responding to these initiations of interaction.
15. For example, just on the Internet one can find reports in *Science Central* (Tanenbaum, 2008), *Science Daily* (2008), The Hindu (2008), *MedHeadlines* (2008), and the New York Daily News (2008).
16. The study reports that: 'The AAT groups received weekly visits lasting 30 minutes from either AIBO or the living dog for 8 weeks. Sessions occurred in the resident's room and consisted of the resident sitting in his or her chair or upright in bed with the dog or AIBO next to the resident. AIBO was kept stationary in its recharging cradle next to the resident, but not allowed to walk about' (AP, 2008: 174). From this description, contrary to what we have been suggesting in this paper, one does not learn whether the dogs (machinic and living) were accompanied by researchers or other care personnel, whether these individuals were the same over the course of the multiple visits, how they interacted with the dogs and the residents, how the encounters between the residents and the dogs took place, and how the settings were reorganized through these interactions.
17. We suspect that the same would be true even if the object was a puppet. Because of the conception of the puppet as intentionally linked to a human operator, the participants would orient to the puppet differently – in other words, the interaction would be a part of a different language game; Wittgenstein (1953: §23–24).

18. This is certainly not to say that only the robot acquires its agency in interaction. A fitting example is the positioning of the ethnographer, whom the toddlers, differently from the roboticists, come to treat as a non-person with no relevant interactional significance. This is, however, also not to say that there are no differences between humans and robots, since the language games in which they are implicated are different. Here we point out how these language games are not only historically shaped, but are importantly instantiated through the spatial organization of objects and the coordination of multimodal semiotic means in the practice of social robotics.
19. See, for example, Hearne (1986: 29).
20. This study parallels Goode's work on how children born with rubella syndrome (and thus deaf and blind, with severe mental retardation and other disabilities) communicate (Goode, 1994).
21. See also Crist (1996) and her account of Darwin's argument for animal–human continuity and descriptions of animal behavior as both meaningful and authored.
22. An interesting, almost 'hybrid', case is Sue Savage-Rumbaugh's bonobo Kanzi, a laboratory-reared ape that learned to understand spoken English. On the one hand, Savage-Rumbaugh (in Savage-Rumbaugh et al., 1998: 6) points out the evolutionary history of the bonobos (their relationship with common chimpanzee and other apes), and their natural habitat in Congo (one must keep in mind, however, that Kanzi is not a member of a companion species, and Savage-Rumbaugh, reminiscent of Hearne's (1986) argument, describes her fear of being attacked and bitten by the bonobo she is training (pp. 10, 17)). On the other hand, she tells how Kanzi learned to comprehend spoken English and to use printed symbols by participating in everyday activities in a primate laboratory where his mother was being taught a language, but without any formal language training directed specifically toward him. By living in the laboratory, Kanzi 'cross(ed) what had been assumed to be an unbridgeable boundary between the world of animals and the world of humanity' (p. 7).
23. David Turnbull (2000) has compared modern laboratories to medieval cathedrals whose construction was accomplished without the use of pre-established plans, but in virtue of what Turnbull calls 'talk, tradition, and templates' (pp. 63–66). 'In both cases the focus is on getting the experiment to "work" through the process of collective practice' (p. 67). Here we align with this argument, but we further highlight the importance of multimodal interaction.
24. Like Boyle's estate, with the household retinue recruited and supplemented (Shapin and Schaffer, 1985), and a classroom, outfitted with facilities for observation (e.g., Bailey et al., 1970), the preschool retains some of its form and priorities while incorporating 'science'.
25. See, for example, Melvin Pollner and Lynn McDonald-Wiker's (1985) discussion of how a family attributes competence to a severely retarded child. This view has been criticized for its derogation of the family's claims while assuming the positions of the clinic to be standard and objective bearers of truth (Goode, 1994: 87; also see Pollner and Goode, 1990).
26. For example, Alač (2009) describes how social roboticists implicate their bodies in the design of a robot, while, at the same time, being compelled to comprehend their bodies through their interactional engagement with it.

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Biographical notes

Morana Alač is an assistant professor of Communication and Science Studies at the University of California, San Diego. She is the author of *Handling Digital Brains* (MIT Press, 2011).

Javier Movellan is an associate project professor at the Institute for Neural Computation and the Director of Machine Perception Laboratory at the University of California, San Diego.

Fumihide Tanaka is an associate professor in the Department of Intelligent Interaction Technologies at the University of Tsukuba.