Reconfiguring the Appearance and Expression of Social Robots by Acknowledging their Otherness

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ABSTRACT
The design of social robots usually does not focus on their kinetic expression, and often follows the assumption that their appearance should be human or animal like. To encourage a broader understanding of the possibilities for design of social robots, and as an inquiry into alternative relations with them, we present two robots, the Lat-Sac and the Blo-Nut, which are purposefully moving away from typical social robot design. We present how we engaged performance experts in the choreographic sketching of their elastic expression, and how we staged the robots in a fictitious near-future scenario to create a discursive space for reflection on emerging relations. Based on these encounters we discuss how acknowledging the otherness of social robots can be valuable in designing as well as growing intriguing relations with them.

Author Keywords
Social Robots; Interactive Performance; Diegetic Prototype; Research through Design; Soft Robotics; Otherness.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

For interaction design research, social robots are a notable category of complex computational objects. Not just the social robot as an object of design that brings together related disciplines such as mechanical and electrical engineering, computer and behavioral science, and industrial and environmental design, but also as an object of design that gives rise to new personal relations between humans and technology. Dominantly, the appearance of a social robot appears to be shaped based on a 'sameness' relation, resulting in robots that look like humans or animals, and raising expectations that their expression and modes of interaction are alike humans or animals. Even though these efforts move forward research and development in social robotics, as interaction designers (and non-roboticists), we see an important role to keep open the design space of social robots by shaping alternative designs that are inspired by aspects that are usually left out or of less concern to roboticists. As such, in this work we are motivated by what could be called a *reconfiguration of the remainder* [11, cf. 36]. This refers to stretching the boundaries of a design space in a deliberately provocative manner, to encourage a broader understanding of the possibilities for design. Following such an approach, we aim to expose perspectives and assumptions in social robot design, put forth critical and novel perspectives for the design of human-robot relations, and inspire and raise reflections on dominant trajectories in social robot design [33, 11].

As contestational objects that invert assumptions and exaggerate excluded qualities we designed the Blo-Nut and the Lat-Sac. Firstly, as an inquiry into an alternative appearance, expression and mode of interaction with social robots, and secondly to understand how it could affect and inspire different human-social robot relationships. The two social robots are purposefully moving away from typical robot designs that look like humans or animals, or a kinetic expression is driven by the achievement of specific goals. Instead, the two social robots are driven by dexterous movements, to give privilege to novel forms of expressivity. In the process of giving form to the robots, we engaged experts who are literate in an expressive language in what we call *choreographic sketching* [38] of the two robots' behavior. For this, we created an interface that non-programmers can use to easily design a dynamic expression and in real-time experience the result. Through these collaborative efforts we intended to gain a wider understanding of the qualities of expressive movement, and explore and exploit the width of design expressions that the individual robots offer. As an inquiry into the possible human-social robot relationships that emerge in interaction with the Blo-Nut and Lat-Sac, and in order to productively engage people with the social robots, we created a fictitious near-future scenario. This scenario positioned the two robots in a story world for which the robots were prototyped [25], in order to create a discursive space for imagination and reflection.

Overall, this work can be framed as a critical note to dominant appearances and expressions of social robots, and

an encouragement of the exploration of alternative approaches, appearances and expression of their design.

SOCIAL ROBOTS

Social robotics is a growing research and design field that is recognized by dedicated journals and conferences (e.g. the International Journal of Social Robotics and the International Conference on Social Robotics) and the multidisciplinary field of Human-Robot Interaction (HRI). Social robots are distinguished from for example industrial robots or military robots by their mode of interaction and purpose of engaging in communicative exchanges with people, *to serve human needs beyond those of labor or common notions of work* [11, p.58]. Most social robots sit between industrial or academic research labs and the consumer market or make their appearance in various forms of fiction. For example, the iCat (Philips), Probo (Free University Brussels) and Huggable (MIT) are research artefacts that are used to respectively investigate robotic facial expressions [1], expression of emotions [31], and affective touch [35]; while the AIBO (Sony), PARO (AIST) and Jibo (MIT Spin off) are consumer products to respectively support companionship, elicit emotional attachment and commitment, and act as partner in the smart home. In fiction, and science-fiction in particular, films such as *I, Robot* (2004), *Ex Machina* (2015) or *Bicentennial Man* (1999) present relations with robots as helper or in adversarial or substitute roles of humans. In terms of designing and researching social robotics, all these efforts are important to explore the possible relations and form-factors of social robots, to aid developers and a wider audience in identifying and speculating about desirable relations and concerns.

Appearance

Notably, what all the above examples of social robots share, is a *visually* oriented approach that focusses on a human-like (anthropomorphic) or animal-like (zoomorphic) appearance [14]. Historically, this is not surprising as the introduction of the word *robot* in the science fiction play *R.U.R.* (1920) referred to artificial people made from synthetic organic manner. However, it is more likely that it can be attributed to an underlying assumption in robot-design, in that resembling a life form eases the acceptance of the robot as a social entity. Or, that the familiarity of appearance and behavior eases the comprehension of social signals and communication with a social robot [32]. Nonetheless, the downside of in particular an anthropomorphic appearance and expression of social robots is that people generally expect a match between a robots' appearance and behavior – it misleadingly suggests that it has the same intellectual capabilities as humans [12]. The 'uncanny valley' is a well-known concept therein, which suggests that if a robot appears and behaves too much like a human, but that it simultaneously is still clearly a robot, it will evoke a feeling of uneasiness or eeriness [27]. It is even posed that anthropomorphic appearances of social robots pose a threat to human distinctiveness, because too much similarity blurs category boundaries that undermines human uniqueness [14]. The desire to create an anthropomorphic robot imposes certain human limitations upon the robot, while alternative and perhaps more appropriate form factors and means of communication are overlooked [12, 32].

Expression

For social robots, a static human or animal like appearance itself is not required in interpreting the machine as a living and social entity. Bartneck argues that the *experience of animation* and the perception of them is crucial for successful HRI [3], while Breazeal describes social robots as the class of robots that people anthropomorphize in order to interact with them [7]. This emphasizes the character of people's relation with robots, and not the robot's appearance in itself. Many computational machines are already experienced on the border of animate and inanimate [37] as people have a tendency to anthropomorphize and to attribute feelings, thoughts and emotions to other entities, such as cars, computers and other machines [34]. Moving a robot machine into the social realm thus requires a focus on expression and not necessarily appearance. However, the expression of a robot through its movement in space is often resulting from a more *pragmatic* approach, where the expression is driven by the robot's requirements to achieve physical goals. This typically results in a mechanical expression and an appearance that looks like an assembly of electromechanical limbs [20]. Both a pragmatic and visual design approach position the design of the robots' expression later in the process. Instead, focusing on the expressive motion and the timing of a robot's motion allows for a plurality of appearances and aroused emotions [8], and for the character of the human-robot relation to develop.

In previous work we have introduced *performing objects* as a way to playfully explore provocative expressions of soft robotic objects [37]. Essentially, this was a shift from developing robots with a function in mind to developing robots with a focus on aesthetic and performative qualities. Through explorations in form, material, and movement, we designed a series of provocative performative objects to embrace aspects that are usually by-products of robot design, such as humorous, appalling, or intriguing complex movement forms. The use of soft robotics worked particularly well in designing expressions, as soft robotics use compliant materials that have similar qualities to those found in organically moving living organisms. Similar to performing objects, Hoffman and Ju [20] proposed an expressive movement centric design approach in interactive robot design, to communicate, engage and offer dynamic possibilities that go beyond the physical form factors or pragmatic motion paths. This prioritizes the communicative aspects of movement in the design of robots, to more accurately express the robot's intent, personality, and intelligence, among others [20]. With an interest in the communicative and expressive movement qualities of

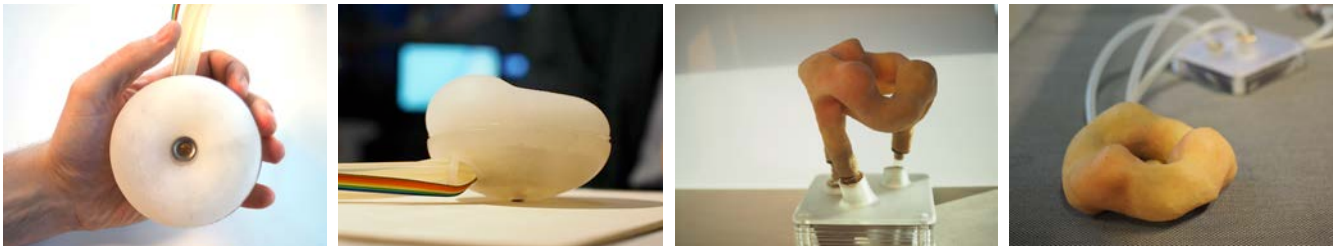

Figure 1. Social Robots: a) The Blo-Nut; b) Blo-Nut actuated; c) The Lat-Sac; d) Lat-Sac removed from its base

robots, performing objects and an expressive movement centric approach both open up to the design of social robots that emphasize their movement qualities.

Modes of Interaction

Labeling a robot as social creates certain expectations about its purpose, functionality and consequent interaction. This interaction is often labelled as communication, to acknowledge the robot as an entity that can be communicated with. For human-like social robots, cybernetic, sociocultural and socio-psychological theories of communication are often employed to reinforce the idea of the robot as another human [32]. Such theories emphasize commonalities with humans, and value the use of humanlike communication channels (voice, facial expressions, bodily gestures), and value the notion of 'sameness'. Instead of this notion of 'sameness' in HRI, the notion of 'otherness' may introduce developers to new forms of robots that see and interpret the world differently, to avoid the 'reduplication of self' [28] and 'the elimination of difference' [29].

Phenomenologically, *the other* is the entity in contrast to which an identity is constructed, and thus assumes the existence of an alternative viewpoint [24]. Otherness in human-robot relations refers to the idea that the robot appears as *an other* that is different from ourselves. In Verbeek and Ihde's terms this means that the relationship with robot technology can be understood as a *quasi-alterity* relation [21, 38], where the robot appears to us as not a thing but as *a quasi-other* entity. This emphasizes the importance of a constant recognition and acknowledgement for its difference, and empowers the idea of the robot as an alive machine [32]. The closest 'living non-human' – human relationship through which we can understand the qualities of such relationship is the animal – human relationship. As an alterity relation with animals, in the sense of their individual personalities and representatives of species, their behavior and demeanor can grant insight into our own experience [10, 34].

Alternative Social Robot Design

To stretch the boundaries of social robot design, it is important to expose the dominant perspectives and assumptions in their design, and to give form to excluded alternative possibilities and approaches [11]. These agonistic activities can act both as a critique and as an inquiry, keeping open a pluralism of design engagements. For this work, it means opposing social robots' common appearances and pragmatic-based expression: tempering zoo- and anthropomorphism and embracing the expressive potential of the robot as a quasi-other. As formulated by Sandy, it is often alternative designs that can push the boundaries of what is possible when humans interact with social robots that are not humanlike or animal like in appearance [33]. Our intention is to encourage, through such acts of design, the development of a broader understanding of the possible relations with social robots. We believe that this wider take on social robots is necessary, as they are increasingly imagined as solutions to various healthcare situations (e.g. care robots, therapy robots) or in domestic environments (e.g. companion robots, play robots), and thus are projected to increasingly play a role in people's lives.

Based on the above design intentions, we describe the Blo-Nut and the Lat-Sac. It is important to note both robots are rooted in and developed from our prior work on *performing objects* [37], which means that the presented robots are not emerging from a social robot community of practice. However, exactly as we take an alternative point of departure, we see potential in how they could offer novel valuable insight to social robot design.

THE LAT-SAC AND BLO-NUT

We designed the Lat-Sac and Blo-Nut as an inquiry into an alternative appearance and expression and secondly to study modes of interaction and possible relations that could emerge with the social robots. For the robot as a social entity, we were inspired by the role and related expression of a dog laying in the corner of a room, with a low, continuous murmuring sound. In line with Sparrow, who argued that the idea of robot dogs comforting and entertaining lonely older persons is both misguided and unethical [34], the idea of the dog in the corner of the room did not mean that our intention was to literally replace pets, nor that we tried to *replicate* the appearance, expression and interaction with a pet. Rather, the presence of a pet embodied qualities that we were inspired by, and following Coeckelbergh [10], it phenomenologically comes the closest through which we can understand the qualities of the relationship. It reflects an entity that plays with being in the foreground and background of the attention through minimal or sudden expressions; an entity that supports setting atmosphere in context; and an entity that offers its

Figure 2. Examples of two designed choreographies: a) Performing artist's 'Mating Evolving'; b) Digital artist's 'The Walk'

availability as interactor. A social robot that takes on such a role allowed us to focus attention on movement expression and appearance first, opposing a more specification driven or visual oriented approach.

We deliberately worked with elasticity and air actuation as seen in soft robotics, as this combination has several benefits in terms of the variety of appearance and expression offered: appearance wise, elastic materials can handle distorting forces and return to an original shape once that force is removed, allowing for a range of different appearances; and expressivity wise, elastic material allows for a play between elastic limits and these different appearances that look and feel organic. As humans have muscles, and humans as living organisms perceive the world in terms of their own body [16], mobilizing elasticity in social robot design opens opportunities for relating to them as alive entities.

The Lat-Sac and Blo-Nut

We named our first robot the Lat-Sac (Figure 1c). The robot is made out of latex and has three plastic tubes connected to it using brass couplings. The latex sack houses three balloons that can each inflate and deflate. It has an acrylic and 3d printed base in which the Lat-Sac can be placed or be removed from (Figure 1d).

We named our second robot the Blo-Nut (Figure 1a). The robot has a shape that roughly resembles a donut, with a plastic 3d printed bottom shell, and a top made from silicone that houses three independently inflatable segments. These can be actuated by blowing air into the pockets between 3D printed inserts and the soft silicone skin. For a detailed account of the design process of the Blo-Nut robot we refer to [38].

Hardware and Interface

Both the Lat-Sack and the Blo-Nut are controlled using the same interface and hardware. One Arduino drives, for each of the three inflatable chambers, a vacuum pump, a solenoid valve, and a motor control board. Three plastic tubes are connecting the robot with this hardware setup (Figure 3a).

The interface is made in Max/MSP, which is often used as music making software, and allows for real time manipulation of the robots. It provides 64 input possibilities for sequential control for each inflatable segment (Figure 2, the 3 rows), in which the strength of the motor can be set (Figure 2, the bars), together with whether or not solenoid is open (Figure 2, the checkboxes above the bars). The overall tempo of the patch can be set to determine the time taken to execute the 64 steps (Figure 2, slider in metronome section). Up to 6 choreographies can be stored in one patch.

DESIGNING ROBOT EXPRESSIONS WITH EXPERTS

As an inquiry into the act of giving form to social robots in alternative expressive ways, we invited three experts who are literate in an expressive language: a contemporary dancer, a digital artist, and a performing artist. We asked these experts to collaboratively explore the width of communication that the Lat-Sac and Blo-Nut can offer, particularly in their physical expression using the previously described designed interface (see Figure 2). Each session took around 75 minutes, where we emphasized participants' role as experts in an expressive form language. We felt this was important in scene-setting, to direct the sessions towards playful explorations, rather than the experts feeling engaged in a formal experiment. We then demonstrated the different features of the interface and gradually left them to explore and get comfortable with these features. We recommended to keep the choreography running at all times, to merge acts of choreographing with acts of experiencing and stimulate continuous reflection. Following the emerging conversation with the design material, we asked the experts to name their designed choreography once they were satisfied with it. The creation of one choreography took approximately 20 minutes. Lastly, we discussed interactive features.

Notably, our expert engagement was deliberately *not* conducted conceptually by for example acting out expressive behaviors [cf. 30]. Instead it was done by engaging the experts directly in shaping the computational material of the robots. Through such setup we intended to avoid a replication of self in the robot's behavior, avoid an elimination of difference between humans and robots, and to embrace and exploit the opportunities offered by the design material [32].

Figure 3. Engaging experts in designing expressions: a) Setup with programming interface, hardware and Blo-Nut; choreographing session with the b) contemporary dancer and c) performing artist

Associations drive Expressions

During the three sessions many associations came up that inspired the design of the expressions. Associations ranged from things (e.g. an organ in a church, toys, a massage chair), flora and fauna (e.g. a small sea creature, an alive plant, a frog pond), activities or processes (e.g. meditation, a walk, a conversation, a mating dance, a metamorphosis of a fictitious creature), movies starring aliens and space ships, or the 'attack-decay-sustain-release' envelope as seen in electronic music making. The performance artist for example described one of his choreographies as: *It could also be a mating dance, like a mating ritual, That it blows up and shows how big it can become, and then, zjup* (making a shrinking movement with his hand)*, because danger arrives or something and it cannot continue its dance…* to then name this choreography as 'mating evolving' (see Figure 2a). Similarly, the contemporary dancer described her choreography as *it's kind of like a frog pond. But like a robotic ambient frog pond. Like in the middle of the night.* The digital artist described one of his choreographies (see Figure 2b) as a conversation: *I named it 'the walk' because I wanted to explore the one-two step thing further… to make it like a three legged jumpy thing. Like a dialogue or whatever it is called when you have three partners*. The width and variety of these associations signaled firstly that the experts were able to mobilize their creativity in the shaping of the expressions, but also that the robots and technological setup had a certain openness that invited a plurality of associations.

Expressions beyond the Interface

Especially the digital artist questioned our designed interface as a means for choreographic sketching of expressions. Firstly, the interface might afford 'filling up' the three rows with bars: *You could almost be seduced by the interface and want to fill it up and draw things.* 'Filling up' was regarded as negative, as silence is a well-known affective communicative component [cf. 22] that the digital artist was actively exploring. Secondly, he saw a discrepancy between the interface and the resulting effect: *There is a difference between the pure-ness of the interface and what the thing does… Actually there is more advanced expressiveness in the physical object than that is available seen up here*. However, this discrepancy was later regarded as a playful component: *There is this playing around with the pure-ness and the trustworthiness of the interface and how the real world behaves. It's so much more fun down here* (where the object was). This showed us the important difference between the geometrical graphical representation of the whole choreography in the interface, and the actual experience of the choreography in its complexity and play between the three air chambers and their dynamic transitions. This emphasized the need for quick feedback-loops between the creation of the expression and the experience: *there is a certain friction between the command and what to expect, which is a thing to explore.* Thirdly, each air chamber could be programmed using 64 steps in total, and each of the chambers always ran at the same tempo. To have a wider and more complex expressive range that stays surprising and novel over longer periods of time, the digital artist proposed to have the ability to change the tempo and number of steps for each chamber individually: *…this is Western styled rhythm. You have three things playing in parallel, but they have the same number of steps. So you never get this phase difference going on. If it is possible to make one say 8 long, and another one 5, and 11, that don't divide easily, you can make things that do not repeat for a long while.* Combined, these comments showed how the expressive range of the choreographies could be exploited more by offering different control structures, even though the actual experience of them already offered complex expressions.

Expressions as Multisensory

The air pumps and valves that were controlling the air chambers were sealed off to block their noise, however the noise wasn't muted completely. The more voltage that ran through the pumps as set through the interface, the louder the resulting noise. Also, the valves produced a typical air releasing sound when they were opened. These sounds and the designed expression were thus tightly coupled, and it became difficult for the participants to separate it from the choreography. The performing artist found ways to actively play with the noise in the design of the expression. He tried to find a balance between the air pumped into the chambers and the amount of power needed for it to block out the

noise as much as possible: *so if I do like this... it will blow up soundless*, resulting in a composition that played with the notion of aliveness: *it makes it very not-human, nor animal, but it still has life. It gets this alienated feeling, that it maybe communicates through this kind of noise that is not very organic, but it still moves organically*. He then played with the combination of the motor making a continuous noise and slowly bringing in motion by opening the valves occasionally: *With this constant drone in the background and then, suddenly, it becomes like… a soundscape and a moving thing at once.* The latter part of the first row in Figure 2a illustrates how that motor is activated (the bars) yet the valve is just occasionally opened (the x's). In one exploration the sound even became the main object of composition: *This very old movie, have you seen it? There's this big alien spaceship coming down and they have to communicate through sounds, and then they, there's this very iconic soundscape that they use for communicating with aliens. I was like, can I get that into it.* The digital artist regarded the noise as unwanted yet also tightly coupled to the designed expression: *I'm trying to avoid listening to the sounds, but it doesn't make sense not to listen to the sound*. He saw a synergy with not just the visual expression and the auditory, but also the auditory and the tactile, as articulated while holding the Blo-Nut: *You see a lot of devices move in the everyday, but you don't* feel *that many devices. So I really like the feel of it, to feel the thing. For me, the motor control is the audio part, and the tactile, the thing I feel most, is the inflation and deflation.* Even though our intention was to focus particularly on the visual expressive motion of the social robots in the expert engagements, the holistic nature of an expression became apparent through the auditory and the tactile considerations.

Performance versus Interactivity

As part of the choreographic sketching sessions we speculated about the interactive or communicative aspects of the robots. The digital artist mainly thought in terms of handling and actions, but was struggling to go beyond direct mapping especially in light of the more complex choreographies: *An almost too obvious thing would be to control the tempo based on input. If it was different, I would really love the idea of to be able to squeeze, and then somehow change what is going on.* He asked himself what the robot would be able to sense: *But still, using the sensor inside as an input. For what? If the sensor should change some behavior besides the speed, what would it be?* To then embrace other aspects of the physical design material: *As an experiment, you have three chambers in here, and if I sort of port the flow toward one chamber, that one could inflate more. How would you experience this?* As an interactive object, he struggled moving away from associations with the animal: *It's super hard for me at least, to avoid this, putting the animal into the thing. But probably as well, because even looking at it, you rarely see things bulk like this, if it is a living thing it is a living animal* to then return to his previous association of the sea monster: *…even though it is this sea monster, it has the size and a behavior a cute thing. So probably when you have this aggressive growing thing, you want to calm it down by stroking it.* The performing artist extended the idea of a performance when asked about interactivity: *it could be like integrated in some kind of costume… As in a performance where it becomes a kind of costume but it is also a performance in itself. A play between me and what it is. Is it scenography, is it a performing thing, or is it a costume?* We recognized that by focusing the inquiry on expressivity, the design and understanding of the interactive, communicative, and social aspects of the robots warranted a different design research approach.

The design session with the experts showed us how both associations and the constraints of the interface aided the shaping of a holistically perceived expression. The engagements led to six designed and articulated choreographies, which showed us the potential in the robots' expressive range. And that the involvement of expert others in the design process is needed to fully recognize alternative movement expressions. Further, the session with the digital artist led to concrete recommendations for the graphical interface that could lead to additional possibilities for expression. However, as expression was our main focus, we downplayed the object of design as a social entity. This explained why it was hard to move away from the object as a performing object, or an object of expression alone.

IMAGINING ROBOT RELATIONS

From the engagements with experts it not unsurprisingly became clear that the interactive and social aspects of the Lat-Sac and Blo-Nut were dependent on a situation of use [cf. 32, 10]. To explore possible emerging robot relationships, we thus needed to frame the robots in a role or context to understand the nature of a possible emerging relation with them. In line with our critical take on a subject matter, we borrowed from speculative approaches to design in our staging of the robots. These approaches provide concepts such as a perceptual bridge [2] to explore the desirability of relations with emerging technological possibilities, and to provoke curiosity and discussion around issues embodied by the design. To establish a discursive space we created a fictional element, a near future story world [25], that was grounded in a familiar or logical reality [cf. 2], in which the Lat-Sac and Blo-Nut were positioned.

November 2021.

The discovery by The Danish Centre for Animal Welfare (DCAW) that pets often suffer from Aboulomania* while kept in a domestic environment has led to an unanticipated and forceful societal response. Keeping for example dogs, cats, hamsters, rabbits or reptiles at home is now frowned upon in many countries.

Mo-tio Inc. are attempting to exploit this gap in the market by developing unique, responsive and expressive behaviors capable

Figure 4. Study participants' engagement with the Lat-Sac.

of evoking emotional responses. The first round of Mo-tio prototypes are dubbed 'The Others'. It is expected that future customers can submit requests for their own 'Other', forming a unique blueprint to start a potentially unpredictable characterization process.

The 'Others' presented here are the first prototypes for evaluation outside the Mo-tio labs. They are beginning to develop their own body language and are starting to show signs of personality and response to human interaction...

**Aboulomania is a mental disorder in which the patient displays pathological indecisiveness. It is typically associated with anxiety, stress, depression, and mental anguish.*

This scenario speaks of 'responsive product movement', to emphasize the expressivity of the Lat-Sac and Blo-Nut and to acknowledge a certain level of interaction with them. This still is deliberately quite abstract (a human-animal relationship is highly dependent on type of animal and people's personal preferences [10]), but it allowed us to keep open a variety of possible emerging relations. Which motivates why we framed them as prototypes for future pets, and not necessarily as finished products. In relation to this setup, it is worth mentioning Dunne and Raby's technological dreams series [13], which is a collection of furniture inspired robots that have their own intelligence and capabilities, designed to stir reflection on possible and desirable relations with domestic robots. Our work also opens up and asks questions about possible relationships with social robots, however, it differs in terms of our focus on exploring these relations with a focus on kinetic expression.

We invited three groups (a total of nine participants, P1-P2, P3-P5, P6-P9) with a background in digital design or design and communication to discuss the robots. Each group session took place in a public coffee place, and took approximately 60 minutes. First, we handed over the above imaginative scenario to suspend disbelief [26], and to create a safe space for speculation and reflection [23]. Next, we handed over a description of the robot that was going to be discussed, in the format of a confidential document from the imagined company Mo-tio Inc. Even though the robots housed sensors, one of the authors live simulated the behavior of the Lat-Sac and Blo-Nut in response to how they were manipulated, without the participants knowing. This illusion of the robots being interactive offered us the possibility to use the choreographies form the experts, and to meaningfully tweak transitions between them.

Between Animal and Machine, Pet and Consumer Product

All of the participants actively contributed to the group discussion, and none of the participants seemed to be alienated by the fictitious scenario. As P2 noted in the middle of a discussion: *But I guess when you are in 2021 and you are trying to save pets from depression, then it is a different experience,* which signaled to us that the scenario was imaginable as a possible world. This could be attributed to the environment and playfulness of the of inquiry, but also as the prototypes were robust and technically working [6]. However, even though the situation was perceived as possible, it was not straightforward for the groups to conceptualize the robots.

The framing of the robots as pets raised particular expectations from the robots that were not always met. It was put forward by several participants that a pet is excited when you come home, that it can be soft and soothing to have a pet, but also that pets require feeding and care, such as walking the dog. This raised expectations with respect to handling the robots as well, e.g. P4 mentioned while P6 was pressing the Blo-Nut: *You are not supposed to do that with pets you know*, or, as P1 in first contact started to carefully handle the Blo-Nut: *the fact you frame it as a pet immediately has a connotation as something that you are gentle with*. Exactly which domesticated animal the robots resembled was source for discussion, e.g. the surface of the Blo-Nut was *like you are touching the belly of a dog* (P2), its weight was *almost too light, like these little tiny hamsters* (P1), the tubes and object combined looked like a snake (P9), or a cat *because it does take care of itself* (P7) and because it sounded like purring in one of the choreographies (P2, P6). The Lat-Sac moved away from resemblance with a pet, into an alikeness with other animals or parts thereof, e.g. a plucked chicken (P2, P4), the udders of a cow (P9, P5), the ear of a pig (P3), or a spineless sea creature like an octopus (P1). Lat-Sac's immobility in combination with its appearance also positioned it as a plant or organism, or a mix of an animal and a plant: *it has a root, a ground source, it needs to be hooked up* (P2

Figure 5. Study participants' engagement with the Blo-Nut.

referring to the tubes); *it's like a plant that you would see in the background of an alien movie* (P8); or, *it falls somewhere between plants and something that has a degree of agency* (P7). Besides the impressions of the robots as alive entities, the Blo-Nut in particular was at the same time seen as a gadget (P1), consumer product (P6), hospital equipment (P2, P3, P9), or laboratory prototype (P3), as *the plastic materials, and the metal, the screw, the bolt, the wires, silicone, make the appearance artificial* (P6) or for its *medical, transparency look* (P9). The Blo-Nut moved towards a machine for some participants, in particular because of its hard shell (P1), geometric appearance (P2, P6), and connotations with a respirator (P2).

The Lat-Sac and the Blo-Nut seemed hard to conceptualize, as they evoked the combination of an alive entity that is a product or machine at the same time. Or in Verbeek's terms [38], the participants both experienced an alterity relation and a hermeneutic relation with the robots. This led to on the one hand a desire to keep the robots alive, e.g. P5 when the Lat-Sac was unplugged from the tubes: *Oh! Oh it died. It's really dead now. Poor thing. Kind of disgusting*, or P2: *can I go on vacation for 14 days and then come home and it's still there?*, but on the other hand it made P6 wonder what happened when the robot was conceived as consumer product: *I would say that your relation with it depends a lot on whether you can turn it on or off. Then you choose to interact with it, so you go to turn it on and then enjoy the experience of it. But if it is always on, always expressing something, you might develop another relationship to it. It also depends if it was a house appliance. Would you just leave it around in your living room, or would you put it away in a closet and take it out whenever you need it?*

The above discussions revealed possible conceptualizations of the robots, which all inevitably lead to different emerging relationships. At a basic level, the discussions showed us that when an artefact is perceived to be alive, it can also be dead or off. We find that conceptualizing the robot as an 'alive machine' [cf. 32] captures our findings of the social robots as perceived living entities that can be switched on and off, which we believe is an inspiring notion for further exploration and design research.

Alive and Breathing

The expressions of the Lat-Sac and Blo-Nut mostly provided impressions of them being alive, as the actuation of the robots was associated with breathing, e.g. P2 with respect to the Blo-Nut: *even though this shape is not something that you would recognize from any animal like alive thing, then you can still really easily see that it is alive, because it is breathing that you can recognize*, or P5 about the Lat-Sac: *it is like suffering, or it is like really tired. And this looks like breathing now*. This perception of breathing was however not consistent and differed per choreography, e.g. P1, *it is a little bit difficult for me to associate it with breathing, because it is also not regular, it is more the way in which it is moving around* or P4 who re-enacted a dog panting and argued that the robots do not express themselves like that. Nonetheless, as potential alive entities, the Lat-Sac and Blo-Nut seemed to express emotions. For P3-P5, their expressive range was positioned on a scale from stressed to calm (e.g. as P3 was stroking the Lat-Sac, P5: *You are upsetting it,* P4: *You stress it out,* P5: *Don't kill it*, P3: *It likes me, haha, I was calming it*). Upon reflection P4 articulates that *stress contains all the negative feelings* to which P5 replies: *because it is so much about the breathing. Normally you are just able to decide if someone is relaxed or stressed by their breathing.* P1-P2 mostly talked about the robots being either more alive and independent or less alive and calm, while P6-P9 projected a wider range of states onto the robots, e.g. as excited, helpless, tired, agitated, angry, comfortable, and calm.

The use of air actuation in combination with the various designed choreographies played a big role in perceiving the robots as alive, which was attributed to the association with breathing or explained by the movement of the robots. The way in which the robots were seen alive however seemed to be restricted to a limited range of emotional or bodily states.

Reciprocity of Sociality

Before and during the sessions we deliberately did not mention our research intention in social robotics, as we were interested in how the robot's appearance and expression reinforces beliefs about what it means to be social [cf. 11]. As mentioned before, relating the robots to

pets set particular expectations about the role of the Lat-Sac and Blo-Nut, and the social character of the emerging relation. This included personal preferences towards particular pets, e.g. several participants recalled what it was like having dogs, hamsters, or cats, and the role they had in their live. These were not necessarily positive memories, e.g. P2 recalled her dog running away from her just before he died, or P4's, who expressed her dislike for cats in her handling of the Lat-Sac (Figure 4c): *that's how you would hold a cat. At its tail*. The personal experiences with entities that were associated with the two robots should thus be taken into consideration in understanding emerging relations. P4, because of her dislike for cats, saw an opportunity for having the Lat-Sac at home: *You could have it at your place, to show it to people. This is my pet! I don't need like a real one, I can have this one, showing it off*. This ties into the notion of popularity as a salient source of pleasure or as a means of providing a worthwhile experience [18]. Along the same lines, P6 saw the Blo-Nut as an object that you could use to achieve a similar experience: *you could have in your purse, like a Chihuahua*. The character of the relation was dependent on what the robots did in return. Besides popularity, being stimulated was identified as another potential quality, e.g. the Blo-Nut was *better to hold in your hand, you can sit in the couch and just watch the TV or something* (P8); or P1 and P2 who mostly held the Blo-Nut with the soft part in their hands to have a *sensation* (Figure 5b); or P1 who placed the Lat-Sac around her wrist (Figure 4b): *there is something soothing wearing it, because then you can feel the inflation on both sides of it*.

However, it was still hard for participants to identify what the robots could do for them and to articulate the character of the relation, e.g. P4: *Because also, what does this give to you?*, to which P3 replied: *a pet loves you back*. This ties into the norm of reciprocity, which in social human to human interaction *may lead individuals to establish relations only or primarily with those who can reciprocate* [17, p.178]. In interaction with the robots, it was thus not entirely clear how the robots reciprocated. This can be explained by the lack of control over the robots (partially due to the live simulation) or, that the kind of control usually felt in interaction with a pet was missing, e.g. P9: *If you were able to be more aware of what it is reacting to, then you'd be more interactive with it*, and P7: *I don't really understand what I am doing that triggers it. Because I would know with a real pet what I would do to calm it, how it would react to me*. Besides the felt lack of control, it was also not clear how the robots were depending on a caretaker for their survival: *It doesn't need human care or anything, also it doesn't need food, I guess you can just count the air as food, so it can kind of take care of itself* (P3). The participant felt unsure if she was really needed and thus taking part in the relationship with the robots. As in [19], we found debate around the value of machines that are autonomous in pet like ways and that have no apparent function.

These mixed relations of the robots on the one hand providing experiences that could stimulate or enhance popularity, and on the other hand, of the robots not being able to reciprocate, showed that they were exhibiting behavior that could be understood as social, yet that the interaction with the robots was not necessarily social. This can be attributed to the live simulation of the robots' expression in the group sessions and the lack of felt control or need, or that there was only a single meeting with the robots (e.g. P3 regarding the Lat-Sac: *it grows on you. In the beginning you think it is more gross, now it is better*, or P2 upon reflection: *this is more, you experience it, you get this emotional and physical attachment*). This hints to the idea that the Lat-Sac and Blo-Nut, when confronted with new eyes, bring *closer the potentially radical Otherness of worlds to come* [9, p.134].

DISCUSSION

In designing the Lat-Sac and Blo-Nut, we have purposefully shaped an atypical, non-human nor clear animal like appearance and expression. Even though resembling a known life form could ease the acceptance of a robot as a social entity or the comprehension of social signals coming from it, we believe that designs grounded in a principle of 'sameness' unnecessarily narrow their design space. In giving privilege to novel forms of expressivity combined with an alternative appearance that is open for interpretation, we find how designs grounded in a principle of 'otherness' could overcome the duplication of self or the elimination of difference, and open up to alternative ways for communication rooted in kinetic expression. In this discussion we want to point to aspects that we found valuable therein, both in the act of giving form to the robots, and the growing of relations with them.

Acknowledging Otherness in Giving Form

Giving form to social robots and ensuring a sense of their otherness means acknowledging that they are, and have abilities that are, not clearly human or animal. In this process we found value in exploring alternative appearances and expressions that on the one hand are interpretable as alive entities, but on the other hand are provocative and invite for a plurality of associations. This requires methods and platforms for designing that go beyond the limitations of the human body, and that provide designers with more nuanced methods for creation. By enabling designers to explore the expressive range that the computational robot material affords, the motion of the robot is factored in from the onset. We found value in especially those materials that invite for playful explorations, such as elastic materials and music-making software that allow a direct experience of a sketched choreography. Additionally, the engagements of experts who are literate in an expressive language can not only inspire new associations, but also bring to the foreground

how to mobilize important choreographic building blocks (e.g. the silence or pause, or the inclusion of other modalities) and inform the shaping of the methods of creation. It is in these activities that we see opportunities for recognizing that the social robot can become an alive machine that is capable of doing different things than humans or animals, inviting for a different kind of relation to grow.

Acknowledging Otherness and Growing Relations

Encountering otherness means encountering differences between the familiar and the unfamiliar. By fictitiously staging the robots in the role of pets we observed emerging relations that were curious and provoking, and not straightforward for the participants to conceptualize. The unfamiliarity of the robots resulted in a natural attempt to comprehend through known elements of the human-animal relation. Though for the participants this did not lead to satisfying conceptualizations in terms of framing the robots as an animal, pet, consumer product or machine. The 'alive machine' [cf. 32] points to an appearance and expression of robots that is open to interpretation, and therein we see an opportunity for social robot design and further design research. The playful and curious character of the relationship with such an alive machine could potentially keep open a certain width and variety of communication that leads to the robots remaining interesting over longer periods of time. Differences should then be seen as an asset rather than a difficulty that must be overcome, leading to novel intriguing relations. Short as the encounters with the robots were, there were hints of intriguing and growing relationships, as reflected in the continuous articulation of associations and the initial perceived emotional expression of the robots. However, to move the social character of the human robot relation from an exhibited behavior to an interactive behavior warrants further work in utilizing the sensing capacities of the robots, to continue the exploration of notions of control and the felt recognition of self in the emerging relationship.

Acknowledging otherness in the process of giving form to, and growing relations with social robots hopefully encourages alternative form factors and interactions. The Lat-Sac and Blo-Nut are a start in one of the many directions for design that we have found constructive, and that we hope to use as stepping stones to future designs. As such, with this work we are not just posing a critique, but also offer designs and a design direction that stimulates a playful and believable shift towards alternatives.

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