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Perception, Imagination and Affect in Human–Robot Relationships

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Abstract

As they arrive in our homes, nursing facilities and educational institutions, urgent questions are being asked about the ethics of encouraging people to have feelings towards social robots that have roles as companions, carers and teachers. This article suggests that the quality of these debates is enhanced by examining how people perceive robots and, in particular, how robots' expressive characteristics stimulate feelings through engaging the embodied imagination. I discuss the perception and expression of the zoomorphic therapeutic robot Paro, before considering the directions an understanding of these processes can take discussions about the aesthetics and ethics of social robots.

Keywords

Robotics; perception; affect; phenomenology; Paro

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The robotic baby harp seal Paro gazes up with large dark eyes set amid soft, thick, white fur, raising its head in response to its name. It bats long eyelashes and waggles its tail, cooing when caressed and squawking if held too tightly. When a dummy-shaped charger is introduced into its mouth, it coyly turns its head away. The robot cries for attention and settles down at night-time. Its actuators are designed to be especially quiet and its mechanisms are well hidden by an abundant coat. Its appeal lies somewhere between a pet animal and a large plush teddy bear.

Paro is a widely distributed and researched example of a zoomorphic social robot designed to stimulate feelings of wellbeing in its interlocutor.[1] It was made available in 2005 as a therapeutic companion for the elderly in Japan and is now used across thirty countries, including Australia where a randomised controlled trial is currently underway.[2] Before the late twentieth century robots were figments of the imagination. Today they are tangible, although still thoroughly entwined with our imagination. When Paro is placed alongside people or on their lap, they stroke, mimic, talk to and cuddle the robot in response to its gestures and sounds. They also engage with it socially in interaction with carers and other patients. Although it is sometimes rejected or discarded, most reactions to the robot are positive and some people enthusiastically embrace the device. Among other affordances, Paro might replace the comfort of a pet or function as a positive communal occupation to pass the time. Research indicates that the robotic seal increases positive affect in the elderly, encourages people with dementia to speak and socialise, and is especially effective when deployed as part of a social experience.[3] In Denmark, where Paro is widely used, a one-day training program for caregivers working with Paro recommends Paro be used as a stimulating activity in an individual or group setting, or as a specifically targeted therapy to arouse, settle down or stimulate memory and language.[4] Across the countries in which Paro is distributed, caregivers generally structure sessions with the robot according to the needs of the participants. Pets are frequently invoked when the device is first introduced to people.

As social robots arrive in our homes, nursing facilities and educational institutions, urgent questions are being asked about the ethics of encouraging people to have feelings towards these devices that have roles as companions, carers and teachers. This article suggests that the quality of these debates is enhanced by examining how people perceive robots, in particular how robots' expressive characteristics stimulate feelings through engaging the embodied imagination.

Paro's most striking expressive features are its eyes, fur, gestures and sounds, which are experienced visually, aurally, tactilely and proprioceptively. Its large and animated orbs almost solely carry the effect of a facial expression, with its remaining face amorphous and still.

1 For the purposes of this discussion social robots are autonomous or semi-autonomous devices that may perform tasks completely autonomously, with partial control and human supervision, or with direct control. They have social roles and are designed to interact and communicate with humans and follow social behaviours associated with their roles.

2 Wendy Moyle et al., 'Effect of an Interactive Therapeutic Robotic Animal on Engagement, Mood States, Agitation and Psychotropic Drug Use in People with Dementia: A Cluster-randomised Controlled Trial Protocol', *BMJ Open*, no. 5, 2015.

3 Kazuyoshi Wada and Takanori Shibata, 'Living with Seal Robots: Its Sociopsychological and Physiological Influences on the Elderly at a Care House', *Robotics, IEEE Transactions on*, vol. 23, no. 5, 2007, pp. 972–80; Wendy Moyle et al., 'Exploring the Effect of Companion Robots on Emotional Expression in Older Adults with Dementia', *Journal of Gerontological Nursing*, vol. 39, no. 5, 2013, pp. 46–53; and Selma Šabanović et al., 'Paro Robot Affects Diverse Interaction Modalities in Group Sensory Therapy for Older Adults with Dementia', *Proceedings of the International Conference on Rehabilitation Robotics 2013*, Seattle, WA, 2013; Cory D. Kidd et al., 'A Sociable Robot to Encourage Social Interaction among the Elderly', in *Proceedings of the IEEE International Conference on Robotics and Automation* IEEE, Florida, 2006.

4 Barbara Klein et al., 'Emotional Robots: Principles and Experiences with Paro in Denmark, Germany, and the UK', *GeroPsych*, vol. 26, no. 2, 2013, 89–99.

The size of the eyes is exaggerated, as are the long eyelashes by which they are framed. Expressive features of robots and animated figures often call heavily on the eyes (for examples, see the robots Kismet, Buddy and Domo, and animated figures like Rango and the *Despicable Me* minions). Paro does not see through its eyes; nonetheless, those interacting with it attribute meaning to them. Eye contact symbolises and generates a sense of connection, and direction of gaze indicates attention and intention.

Paro's eyes (and those of many animated figures) also establish the device's cuteness, evoking associations with human and animal infants, as well as associated ideas and feelings concerning powerlessness, care and tenderness. The exaggerated eyes are set amid the robot's blobby shape and fluffiness in a manner characteristic of cute objects, as noted by Sianne Ngai, who writes that a typical cute object has a 'simplistically simplified and even unformed' face.[5] The affective effects of cuteness are not achieved by realism, but by exaggerated expressive features—simplification and formlessness—that are readily seen in Paro.

Paro's expressive movements, registered by its interlocutor visually and sometimes tactilely, are limited to batting its eyes, sliding its flippers back and forth, raising and lowering its head, moving its head from side to side and tail wagging. These simple gestures have a powerful effect, their presence and timing express pleasure, displeasure, desire and recognition. The robot raises its head and bats its eyelids in response to hearing a voice, movements of recognition and need that call for an affective response. The robot's stillness conveys satisfaction and rapid motion conveys happiness and excitement. The significance of gestures is intensified and anchored by the sounds of the robotic seal, its crying and cooing is modelled on those of a baby harp seal and reminiscent of a variety of young animals, setting in motion associations with satisfaction, pain or need. Following Maurice Merleau-Ponty, the perception of such expressions can be perceived as driven by an embodied imagination that entangles affects with perceptual processes, allowing for the direct perception of feelings.[6] This imagination is not associated with inner images, fantasies or make-believe; rather, it is present in and shapes all processes of perception, such as those that underlie human–robot interaction. It infuses and moves the body, incorporating social imaginaries so that interaction with robots circulates social and cultural norms and values enmeshed with affects.

Most strikingly, Paro is covered with a thick, pale fur coat, each one individually hand-trimmed to give the robot a unique quality and an appealing fluffiness that is a familiar attribute of cute objects. Cute as an aesthetic 'depends on a softness that invites physical touching', writes Ngai.[7] The coat is luxurious, soliciting people to engage with the robot through touch and proprioception, evoking stuffed children's toys, long-haired 'ornamental' pets and furred clothes. A number of studies record how subjects gently stroke or touch Paro when initiating and continuing positive interaction with the device.[8] This tactility lies at the heart of research into Paro that views it as a kind of 'snoezelen' or multi-sensory

5 Sianne Ngai, 'The Cuteness of the Avant-Garde', *Critical Inquiry*, vol. 31, no. 4, 2005, p. 816.

6 Maurice Merleau-Ponty, *Phenomenology of Perception*, trans. Colin Smith, Routledge and Kegan Paul, London, 1962, pp. 235–82.

7 Ngai, p. 815.

8 Ruby Yu et al., 'Use of a Therapeutic, Socially Assistive Pet Robot (PARO) in Improving Mood and Stimulating Social Interaction and Communication for People With Dementia: Study Protocol for a Randomized Controlled Trial', *JMIR Research Protocols*, vol. 4, no. 2, 2015; Wendy Moyle et al., 'Social Robots Helping People with Dementia: Assessing Efficacy of Social Robots in the Nursing Home Environment', in *The 6th International Conference on Human System Interaction (HSI)*, Gdansk, 2013, pp. 608–13; and Klein et al.

therapy.[9] Ideas, words, values, mechanisms, calculations and sensations informing the tactile imagination circulate emotions and affects. Touch has compelling literal and metaphorical associations, sliding between an immediate physical act and more metaphorical meanings, signifying contact between entities and intimacy. As Mark Paterson observes, touch 'is a sense of communication. It is receptive, expressive, can communicate empathy. It can bring distant objects and people into proximity.'[10] More often than not, one touches things and people that one is comfortable with. The literal and metaphoric dynamics of tactility channel pre-subjective affects, such as the warmth felt when hands sink into soft fur, as well as subject-oriented emotions such as 'I am happy it likes me touching it' and 'I care for this vulnerable entity'. Writing of when different species touch—and Paro is related to a furry animal species—Donna Haraway posits that 'touch ramifies and shapes accountability'; it 'has consequences' so that a person is entangled with that which she touches.[11]

The act of touching the fur takes the form of a caress, which elicits compelling associations in its performance of the giving of care and pleasure. As examined in Emmanuel Levinas's work (although not in terms of animals or robots) and later interrogated by Luce Irigaray, the caress has a profound existential aspect as an expression of love, as a gesture that is not intended to conclude with an object but seeks a response from an Other.[12] Empirically, engaging proprioception has been observed to increase emotional engagement, something that is regularly exploited in the development of video games.[13] In eliciting the caress, Paro is eliciting feelings of comfort, care and tenderness. Research subjects interacting with Paro engage in nurturing behaviours such as feeding and covering the device with a blanket.[14] When caressing Paro, people regulate their own gestures to elicit desired responses so that, to use Morana Alač's phrase, 'the robot's body reconfigures human movement'.[15]

As Merleau-Ponty notes, the perception of bodies is reversible. The lived body is perceived by the bodies it perceives, and Paro is a machinic example of this. Although attuned to human expression, Paro's perception differs from human perception. A network of touch, light, sound, temperature and posture sensors measure data that is processed via artificial intelligence (AI) software.[16] Its whiskers are touch sensitive and a skin of sensors lies below its fur, which detects force, magnitude and location. These sensors are an important determinant of the robot's behaviour. The sensors on its back, belly and flippers are used to establish whether it is being stroked or hit, whether it is touching the human body or being held too tight. A sound sensor detects the direction of voices and a light sensor hidden in Paro's nose determines whether it is day or night.

9 Selma Šabanović et al.; Wan-Ling Chang et al., 'Use of Seal-Like Robot PARO in Sensory Group Therapy for Older Adults with Dementia', *Proceedings of Human Robot Interaction Conference 2013, Late-Breaking Reports*, Tokyo Japan, 2013; and Marceel Heerink et al., 'A Kind of Snoezelen: Requirements for a Therapeutic Robot for Older Adults with Dementia According to Caregivers', *RO-MAN, 2013 IEEE*, Gyeongju, 2013.

10 Mark Paterson, *The Senses of Touch: Haptics, Affects and Technologies*, Berg, Oxford and New York, 2007, p. 1.

11 Donna Haraway, *When Species Meet*, University of Minnesota Press, Minneapolis, 2007, p. 36.

12 Emmanuel Levinas, *Totality and Infinity*, trans. Alphonso Lingus, Duquesne University, Pittsburgh, 1969, pp. 257–60. Luce Irigaray, *An Ethics of Sexual Difference,* trans. Carolyn Burke and Gillian C. Gill, Cornell University Press, Ithaca, New York, 1993, pp. 154–79.

13 Eugénie Shinkle, 'Video Games, Emotion and the Six Senses', *Media, Culture & Society,* vol. 30, no. 6, 2008, pp. 907–15.

14 Klein et al., p. 95.

15 Alač, p. 508.

16 Brenna D. Argall and Aude G. Billard, 'A Survey of Tactile Human–Robot Interactions', *Robotics and Autonomous Systems,* vol. 58, no. 10, 2010, p. 1159–76.

Information from Paro's sensors, particularly the touch and sound sensors, is processed by algorithmic AI software, which drives the selection and execution of a finite number of behaviours.[17] There are pet and therapy versions of its software; either can be loaded depending on the intended application, varying its responsiveness and ability to store information so that it can tailor behaviour to particular users. The software uses a Reinforcement Learning Framework to select its response, so its behaviour is potentially adaptive and its classification of human touch as positive or negative is used for its behaviour selection. Versions with voice recognition software are able to learn a few words and respond to keywords, such as its name and greetings.

The physical sensors and algorithmic processing software of Paro—machinic and computational elements—are distinctive features of its expression and perception. The quantification of human feeling and expression that occurs in human–robot interaction is a conspicuous difference between how Paro perceives and how the human lived body perceives. The robot's perception measures people's gestures, a measurement that is presented back to them in the robot's expression. This quantification suggests that Paro is an example of what Don Ihde terms a hermeneutic technic, although it is more common to view robots as an example of alterity relations (wherein technology is experienced as having a kind of quasi-otherness).[18] Giving a paradigm example of a thermometer, Idhe writes: 'A hermeneutic relation mimics sensory perception insofar as it is a kind of seeing as ____ [*sic*]; but it is a referential seeing, which has as its immediate perceptual focus seeing the thermometer.'[19] The technological artefact is 'read' and perceived as representing the world, as occurs when a person reads the temperature on the thermometer rather than perceiving the temperature itself. Comparably, Paro measures touch and speech and translates it into non-isomorphic data, which is then presented back to the interlocutor as sound and gesture to be 'read' as indicators of feelings of care or anger. Socially constituted norms are employed in how the robot treats information (for instance, norms of what constitutes painful or pleasurable touch, or affectionate or angry voices), and how it is expressed by the robot (for instance, norms of what constitutes a cry of pain or wriggle of pleasure). The process thus quantifies feeling, participating in the practice of presenting emotions numerically that Otniele Dror traces from the late nineteenth century to contemporary affective computing.[20] This process of measurement incorporates a social imaginary and its customs and standards.

Like its expression, the physical structures and algorithmic processing that are Paro's perception call upon an embodied imagination borrowed from its creators and interlocutors. Its tactile sensors do not just register electrical charge in the human body, they are designed to register certain charges as pain and affection. Its sound sensors and associated software do not just measure volume and recognise a few words, they assess tenderness and attention. For many people, Paro is a generator and circulator of positive feeling via sensations of touch, hearing, sight and proprioception and their associated imaginings, as indicated by the frequency of smiling and laughter during people's interactions with the device.[21] Thought of

17 Ibid.

18 Don Ihde, *Technology and the Lifeworld: From Garden to Earth*, Indiana University Press, Bloomington, 1990, pp. 80–97, 97–108. See also Mark Coeckelbergh, 'Humans, Animals, and Robots: A Phenomenological Approach to Human-Robot Relations', *International Journal of Social Robotics*, vol. 3, no. 2, 2011, p. 198.

19 Ihde, p. 85.

20 Otniel E. Dror, 'Counting the Affects: Discoursing in Numbers', *Social Research*, vol. 68, no. 2, 2001, pp. 357–78.

21 Yu et al.; Moyle et al., 'Social Robots Helping People', pp. 1–2; Kazue Takayanagi, Takahiro Kirita and Takanori Shibata, 'Comparison of Verbal and Emotional Responses of Elderly People with Mild/Moderate Dementia and Those with Severe Dementia in Responses to Seal Robot, PARO', *Frontiers in Aging Neuroscience*, vol. 6, 2014.

as an intersubjective lived body in connection and continuity with others, Paro's perception is not reducible to straightforward sensor data and its processing, but is mediated by the cultural and social imaginary—for instance, through language (verbal and bodily), values (what is positive and negative attention) and narrative (when I care for a vulnerable being it will care for me back).

Focusing on how social robots are perceived emphasises the continuity between social robots and other expressive practices and technologies, such as artworks, film and video games. These connections help move thinking about social robots away from the tendency of technoscience to understand 'its own project as the articulation of the real', and on towards questions about the aesthetics and ethics of the imagination and its engagement with robots.[22] In this approach, the evaluation of people's feelings towards social robots should not be made in terms of whether those feelings are true and authentic or false and manipulated, but with regards to how such feelings circulate within the broader structures and behaviours in people's lives. Below I examine more closely the way the perception and expression of the zoomorphic therapeutic robot Paro involves embodied imagination and affect. I then examine processes of direct and reversible perception, before considering the directions these concerns take discussions about the aesthetic and ethics of social robots.

Direct perception, embodied imagination and the circulation of feeling

Examining processes of the embodied social imagination present in perception aids an understanding of how the perceptual and expressive processes of Paro circulate affect. Merleau-Ponty has shown there is a fundamental creativity of perception integral to lived bodies and artworks that arises from the way the embodied imagination organises perception.[23] There is no sensation independent of perception, which, resonant with temporality, incorporates a web of relationships between sensations, ideas, memories and feelings (as far as these things can be distinguished). Unlike those understandings of perception that distinguish it from pre-personal sensation, this embodied perception is pre-personal.[24] The synaesthetic aspects of this approach are often discussed, for it understands each sensory mode to be set among the other senses so that experiences—and media—seemingly in one sensory mode are permeated with the other senses.[25] Also important is the way the imaginative processes inherent in perception are experienced directly via the expressive features of things, something very apparent in the perception of artworks.

Kathleen Lennon describes this process as one of 'direct perception', in which the grasp of the expressive content of art occurs without inference to an underlying subjective state but directly with the perception of expressive content.[26] For example, when a colour

22 Jackie Stacey and Lucy Suchman, 'Animation and Automation: The Liveliness and Labours of Bodies and Machines', *Body & Society,* vol. 18, no. 1, 2012, p. 23.

23 Merleau-Ponty himself did not fully formulate a theory of the imagination but it is implicit in his account of the way the lived body organises perception. See Merleau-Ponty, *Phenomenology of Perception*, pp. 235–82 and Kathleen Lennon, 'Imaginary Bodies and Worlds', *Inquiry,* vol. 47, no. 2, 2004, pp. 115–7.

24 For example Brian Massumi's widely adopted understanding of affect sees pre-personal affect and sensation as contrasted with perception. See Brian Massumi, *Parables for the Virtual: Movement, Affect, Sensation*, Duke University Press, Durham, 2002, pp. 27–8.

25 Merleau-Ponty, *Phenomenology of Perception*, pp. 266–7.

26 Kathleen Lennon, 'Imagination and the Expression of Emotion', pp. 292–8. See also Merleau-Ponty, *Phenomenology of Perception*, p. 175.

evokes a feeling, that feeling is experienced directly with the perception of the colour. Or a person's perception of Paro's soft body occasions a feeling of care. And, extending the notion of direct perception to tactile, proprioceptive and kinaesthetic senses, when a person perceives herself caressing Paro tenderness is experienced. The link between movement and affect is firmly secured by Merleau-Ponty, who explains that bodily gesture is constitutive of feeling (as well as thought) because 'the expressed does not exist apart from the expression'.[27] Consequently, the 'gesture *does not make me think* of anger, it is anger itself'.[28] By this understanding, expressing a feeling instantiates the feeling. Perception enfolds the world into a body, occasioning feeling of how the lived body is affected by that perception. Affect here is a sense of perception's valence for that body. Not only is there no sensation independent of embodied perceptual processes, but perception is inextricably bound up with affective experience.

Direct perception helps explain how it is that people have feelings towards Paro regardless of the beliefs they hold about the 'real' nature of the robot. I may know that Paro is simply a machine that does not care for me, but nonetheless experience emotional warmth when interacting with the device. Sherry Turkle and others describe how people—even roboticists—develop strong caring feelings towards robots despite their belief that robots are not living beings.[29] In this way social robots are similar to artworks, which also engage the imagination to provoke people's feelings regardless of the beliefs people hold about them. People's response to artworks such as films, paintings, novels and theatre often occur whether a story is true, a character is real or, indeed, whether anything or anyone depicted is recognisable.[30] This similarity between artworks and social robots is increasingly apparent in the ongoing convergence between social roboticists, animators, animatronics and puppetry.[31] Among other things, these practices create and vitalise faces and bodies to display character and to elicit and express emotion. They share the need to avoid the notorious 'uncanny valley' and the goal of animating the inert.[32] Less often commented on is the way both social robots and artworks evoke affect through non-representational perceptions via the embodied imagination.[33]

Significantly, in this process the embodied imagination calls upon a social imaginary for, as Lennon points out, its forms and values arise from social processes.[34] Historically and culturally specific social imaginaries are shared across collectives and entrenched in

27 Merleau-Ponty, *Phenomenology of Perception*, p. 169.

28 Ibid., p. 214.

29 Sherry Turkle, *Alone Together: Why We Expect More from Technology and Less from Each Other*, Basic Books, New York, 2011, pp. 23–147. See also Matthias Scheutz, 'The Inherent Dangers of Unidirectional Emotional Bonds between Humans and Social Robots', in *Robot Ethics: The Ethical and Social Implications of Robotics*, ed. Patrick Lin, Keith Abney and George A. Bekey, MIT Press, Cambridge, MA, 2011, pp. 211–4.

30 In philosophy this is termed the problem of 'fictional emotions'. See for example, Richard Moran, 'The Expression of Feeling in Imagination', *The Philosophical Review,* vol. 103, no. 1, 2004, pp. 75–106.

31 Cynthia Breazeal et al., 'Interactive Robot Theatre', *Communications of the ACM,* vol. 46, no. 7, 2003, pp. 76–85; Jesse Gray et al., 'Expressive, Interactive Robots: Tools, Techniques, and Insights Based on Collaborations', *HRI 2010 Workshop: What do Collaborations with the Arts have to say about HRI*, Osaka, 2010; Derek Scherer, 'Movie Magic Makes Better Social Robots: The Overlap of Special Effects and Character Robot Engineering', *Journal of Human–Robot Interaction,* vol. 3, no. 1, 2014, pp. 123–41; and Scheutz, pp. 211–4.

32 The uncanny valley is a widely discussed hypothesis proposed by Masahiro Mori. It proposes that most people experience a sense of revulsion when they perceive features that look and move almost like humans, but that are not exactly alike and lack key human features.

33 For further discussion of this relationship see Vivian Sobchack, 'Animation and Automation, or the Incredible Effortness of Being', *Screen*, vol. 50, no. 4, 2009, pp. 375–91 and Stacey and Suchman, pp. 1–46.

34 Lennon, 'Imaginary Bodies and Worlds', pp. 107–22.

institutions, devices and cultural practices, in this case robotics.[35] Social imaginaries overlap and inform individual bodies' imaginative processes and the affects entwined with them. The way direct perception draws on an embodied and social imagination sits comfortably alongside the considerable research that demonstrates how sensations are always part of a particular sensorium, organised into hierarchies and relationships in historically specific bodily practices.[36] As Vivian Sobchack points out in her discussion of the lived body of cinema, sensation is always mediated and calls upon particular sets of sensory practices and values.[37] Cinema and other technologies train perception, establishing associations between sensory experience and feelings, ideas and actions, expands Elizabeth Stephens.[38] Likewise, Paro produces historically specific perceptual and affective experience. Its call on the sensations of touch and proprioception is not a call on universal bodily qualities, but on specific culturally embedded perceptual regimes.

As a historically embedded sensory technology, social robots are continuous with a range of sensorily dense technologies with which people interact, such as films, virtual reality and games, to name some products of what David Howes terms 'hyperaethestic' culture.[39] Interactive and gesture-driven features distinguish Paro from cinema, but place it in continuity with gaming technologies such as Wii and Kinect that similarly employ mechanical entrainment through kinaesthetic and proprioceptive senses in addition to vision and hearing. Devices such as an Xbox One controller go beyond employing direct touch simply to communicate data (like a touchscreen does) in their stimulation of the tactile imagination through vibration. Engaging, quantifying and provoking affect is crucial to such entertainment devices (that may also be used for therapeutic purposes) as well as machines like the Smile-O-Meter, which measures an individual's smile so that she or he can adjust it to accord with the standards of Japanese workplaces.

The reversibility of perception: incorporating the machinic

Paro is an interactive technology that engages in perceptual processes of its own, making the perception of the robot reversible. According to Merleau-Ponty, the lived body's perception of another body is reversible because it incorporates into its perception the experience that it too is perceived. Paro can be considered to be a kind of machinic lived body that can perceive its interlocutor by its own methods. A precedent for such a machinic lived body is found in Sobchack's exploration of film as an extension of the filmmaker's and spectator's lived bodies and their processes of expression and perception. The film, she writes, 'transcends the filmmaker to constitute and locate its own address, its own perceptual and expressive experience of being and becoming'.[40] The filmmaker's and viewer's perceptions are mediated by the camera and projector, with film re-presenting the filmmaker's perception, which is in turn perceived by the spectator when viewing the projected film. Like the relationship between

35 Moira Gatens and Genevieve Lloyd, *Collective Imaginings: Spinoza, Past and Present,* Routledge, London, 1999, p. 143.

36 See for example David Howes (ed.), *Empire of the Senses*, Berg Publishers, Oxford and New York, 2004.

37 Among her relevant work see Vivian Sobchack, *Carnal Thoughts: Embodiment and Moving Image Culture*, University of California Press, 2004, p. 135–62.

38 Elizabeth Stephens, 'Sensation Machine: Film, Phenomenology and the Training of the Senses', *Continuum*, vol. 26, no. 4, 2012, pp. 529–39.

39 Howes, pp. 281–303.

40 Vivian Sobchack, *The Address of the Eye: A Phenomenology of Film Experience,* Princeton University Press, Princeton, 1992, p. 9.

self and Other, the relationship between spectator and film is reversible, that is, the spectator's perceptual experience is informed by an embodied awareness that she too can be perceived by the Other—in this case, film.

Sobchack's analysis of the reversibility of film substantiates that a machinic lived body expresses and perceives in a manner not reducible to its mechanisms. She articulates the way people's interaction with such a body incorporates an awareness of its distinct 'perceptual and expressive existence'.[41] This relationship is both embodied and hermeneutic. In these respects, the reversible expression and perception of film is comparable to that of social robots. Paro's cameras and sensors perceive, and its sounds and gestures express, circulating meaning and feelings in ways not fully governed by representation and signification. This is not to deny important differences in the way film and social robots mediate experience. That human–robot expression and perception usually aim to work in real time, whereas human–film interaction typically does not, is just one example of their varying temporal and spatial structures. Nevertheless, like film, robots exercise reversible perception and expression in ways particular to the material and imaginary technologies of mechanical bodies.

Leaving to the side its broader ontological implications, Merleau-Ponty's notion of reversibility goes beyond ideas of the self-sufficient subject to convey the entwinement and interdependency of self–other relationships.[42] Although *Phenomenology of Perception* gives the impression that the relationship between bodies is one of reciprocity and an assumption of sameness ('It is as if the other person's intention inhabited my body and mine his'[43]), in Merleau-Ponty's later work reversibility more certainly articulates an encounter with difference. His famous example of reversibility shows how the self's experience of itself touching depends on an embodied awareness that it too is tangible and is able to be touched.[44] This awareness that the perception of another entails discerning that the other is perceiving one's self is, as Jack Reynolds writes, a 'non-dualistic divergence between touching and being touched, which necessitates some form of encroachment between the two terms … [and] means that the world is capable of encroaching upon and altering us, just as we are capable of altering it'.[45] With reversibility our selves are open to an Other—in Paro's case, a machinic Other—that becomes enfolded into our selves and constitutes our lived body and subjectivity. In establishing a circulation of normative affect through mechanical entrainment, Paro and other social robots produce not only affects and sensations but also subjectivities, bodies and selves.

Paro and its interlocutors are in a relationship of 'mutually constituting, intraactive touch', to quote Haraway.[46] The robot could be considered a kind of companion species, one of those others that people bond with and 'coshape'. Like a horse and trainer, human and robot are 'cause and effect of each other movements' in a process of 'nonmimetic attunement'.[47] Yet, as

41 Sobchack, p. 9.

42 For a discussion of reversibility in its more substantial sense, including a discussion of how the notion is expressed in the *Phenomenology of Perception* and further developed in *The Visible and the Invisible*, see David Morris, 'The Enigma of Reversibility and the Genesis of Sense in Merleau-Ponty', *Continental Philosophy Review,* vol. 43, no. 2, 2010, pp. 141–65.

43 Merleau-Ponty, *Phenomenology of Perception*, p. 214.

44 Maurice Merleau-Ponty, *The Visible and the Invisible*, pp. 146–9; and Jack Reynolds, 'Merleau-Ponty, Levinas and the Alterity of the Other', *Symposium: The Canadian Journal of Continental Philosophy,* vol. 6, no. 1, 2002, p. 68.

45 Reynolds, p. 68–9.

46 Haraway, p. 6.

47 Ibid., p. 229.

one of many heterogeneous encounters with difference, touching Paro diverges from touching a pet. Eleanor Sandry points out that interactions between humans and zoomorphic robots, such as Paro and the mechanical dog AIBO, are 'designed to proceed in ways that are easy for humans to understand' and so 'become stereotypical versions of human–pet relations'. These stereotypical relations 'do not draw attention to the otherness of animals'.[48] In its human-created animality Paro is, in Haraway's terms, 'a technological compound of conjoined forces', a particular assemblage of machine, animal, human that produces each.[49] To touch Paro is to connect with its cultural, technological, economic and biological contexts.

Perception and the circulation of social imaginaries in robotics

With powerfully expressive machinic technologies questions must be asked about what is being enfolded into the embodied self, questions that bring together aesthetics and ethics. A set of obvious but important problems relates to the cultural norms and standards being incorporated into the bodily imagination. With Paro, norms are present throughout the perceptual and expressive cycle and take many different forms: gesture, sound, image, facial expression, pressure, interpersonal distance and so on. With regard to gender standards, for example, such norms may lie in facial recognition algorithms that identify gender, in the expressions made once gender has been identified, and in the gendered stylising of robotic faces and bodies. Norms in the form of numbers and imaginary associations (which are not entirely unrelated) are both important here. The algorithmically driven perception and expression of the social robot introduces a quantification of affect into the core of the perceptual process. All norms and standards involved—quantified and associative—imbue the embodied imagination of the robot user, consolidating relationships between bodily sensations, ideas, feelings and so on. Critical analysis of these relationships is crucial to investigating whether they contribute to what Lennon has described as a 'damaging social imaginary', that is, a social imaginary that inhibits, restricts or distresses individuals when it demands a response.[50]

A number of researchers are paying close attention to how the field of robotics perpetuates and challenges cultural values. Lucy Suchman has examined how the humanoid robots Martz, Kismet, Robota and Lucy embody claims about humanness.[51] The anthropologist Jennifer Robertson has articulated the cultural logic underlying Japanese humanoid robots, showing how new technologies such as robotics can consolidate conservative values.[52] Selma Sabanovic writes of how the developers of Paro, as well as those of other robots, 'co-construct Japanese culture and robotic technology through their discourses and practices'.[53] Sabanovic observes that developers contextualise the making of Paro in terms of local handicraft traditions in Nanto (where the robot is manufactured), which 'replaces handmade crafts with industrial

48 Eleanor Sandry, *Robots and Communication*, Palgrave Macmillan, 2015, p. 44.

49 Haraway, p. 250.

50 Lennon, 'Imaginary Bodies and Worlds', pp. 116–8.

51 Suchman, pp. 199–245. For work on Lucy see Claudia Castañeda and Lucy Suchman, 'Robot Visions', *Social Studies of Science*, vol. 44, no. 3, 2014, pp. 315–41.

52 Jennifer Robertson, '*Robo Sapiens Japanicus*: Humanoid Robots and the Posthuman Family', *Critical Asian Studies*, vol. 39, no. 3, 2007, p. 371.

53 Selma Šabanović, 'Inventing Japan's "Robotics Culture": The Repeated Assembly of Science, Technology, and Culture in Social Robotics', *Social Studies of Science*, vol. 44, no. 3, 2014, p. 345.

production and transfers local consumption practices to a global market'.[54] Certainly research has shown that there are cross-cultural differences in how Paro is received.[55] Careful examination of the perception and expression of robots and their interlocutors, in particular the entwinement of affect and perception in embodied imaginative processes, is a vital addition to these current understandings of the ways social robots circulate cultural values.

The above considerations are especially relevant to critical analysis of robotics as a site for the production of social identities, and certainly research on gender and robotics suggests that entrenched social imaginaries are often reproduced. I focus on gender here because it is a topic on which research has been conducted, but one could equally focus on other aspects of identity. Robertson's discussion of robosexism in Japan concludes that 'humanoid robot bodies are effectively used as platforms for reducing the relationship between bodies and gender from a contingent relationship to a fixed and necessary one'.[56] Illustrating how cultural norms become embodied in robots, Robertson notes that the face of Ishiguro's gendered robots Actroid Repliee Q2 is a composite of the average Japanese female face, while the HRP-4C has a body based on the average dimensions of young Japanese females as recorded in the Japanese body database.[57] More recently, Francesca Ferrando's interviews with undergraduate and graduate cybernetics students show that AI and robotics in the United States, although harbouring a potential to divest gender from biology, are 'developing under a predominantly male imagination'.[58]

Most research relating to gender and robotics investigates how robot gender impacts on the human user, and how gender stereotypes projected by people interacting with robots can encourage acceptance of humanoid social robots.[59] Notably, some robotics researchers conclude or even assume that there are instances when it is acceptable to exploit stereotypes for a positive function, for instance, an elderly person might find a stereotypically gendered robotic behaviour more acceptable and so be more accepting of a therapeutic intervention.[60] The capacity of such an approach to perpetuate damaging social imaginaries in a circular fashion is substantial, given the potential for empirical research to show that the use of dominant and normative gender associations and standards leads to acceptance, thus extending their dominance. As Suchman writes, 'the fear … is that the discourses and imaginaries that inspire them will retrench received opinions rather than challenge and hold open the space of possibilities'.[61] Investigating processes of direct expression holds open such possibilities.

54 Ibid., p. 360.

55 Takanori Shibata et al., 'Cross-cultural Studies on Subjective Evaluation of a Seal Robot', *Advanced Robotics,* vol. 23, no. 4, 2009, pp. 453–8.

56 Jennifer Robertson, 'Gendering Humanoid Robots: Robo-Sexism in Japan', *Body and Society,* vol. 16, no. 1, 2010, p. 6.

57 Robertson, 'Gendering Humanoid Robots', pp. 23–4.

58 Francesca Ferrando, 'Is the Post-Human a Post-Woman? Cyborgs, Robots, Artificial Intelligence and the Futures of Gender: A Case Study', *European Journal of Futures Research*, vol. 2, no. 1, 2014, p. 15.

59 Julie Carpenter et al., 'Gender Representation and Humanoid Robots Designed for Domestic Use', *International Journal of Social Robotics,* vol. 1, no. 3, 2009, pp. 261–5; Yvette Pearson and Jason Borenstein, 'Creating "Companions" for Children: The Ethics of Designing Esthetic Features for Robots', *AI & Society,* vol. 29, no. 1, 2014, pp. 28–30 and Benedict Tay et al., 'When Stereotypes Meet Robots: The Double-edge Sword of Robot Gender and Personality in Human–Robot Interaction', *Computers in Human Behavior,* vol. 38, 2014, pp. 75–84.

60 Friederike Eyssel and Frank Hegel, '(S)He's Got the Look: Gender Stereotyping of Robots', *Journal of Applied Social Psychology,* vol. 42, no. 9, 2012, pp. 2213–30 and Siegel et al., 'Persuasive Robotics: The Influence of Robot Gender on Human Behavior', in *Proceedings of the International Conference on Intelligent Robots and Systems,* IEEE, St Louis, 2009.

61 Lucy Suchman, 'Subject Objects', *Feminist Theory,* vol. 12, no. 2, 2011, p. 130.

It extends the understanding of how problematic entrenched imaginaries are engaged by robots and how they might be sidestepped and reimagined. A conservative approach is not inevitable or necessarily pragmatic, and research should also explore the potential for robots to challenge stereotypes.[62] For example, Sandry's work on the place of otherness in human–robot collaboration recommends allowing a robot 'to be considered familiar enough in its behaviour to interpret its movements as meaningful while also leaving space to acknowledge its fundamental differences from both humans and animals'.[63]

Importantly, of concern are not only those norms and standards that explicitly represent the humanoid body, but also the norms and standards of direct perception and expression, insofar as we have seen that the non-anthropomorphic Paro's expressive features draw on an embodied social imaginary. The direct perception of affect accounts for the way robotic designs pursuing strategies other than anthropomorphism, such as zoomorphism or abstracted designs, are emotionally effective. With this it needs to be recognised that zoomorphic and seemingly abstract designs are not free of cultural norms and standards of intersubjectivity. Although designing non-anthropoid robots might sidestep some of the ethical, social and practical problems associated with anthropoid robots, the shift does not completely avoid such difficulties.[64] If, as Alač writes, 'getting into "the body of the machine" fashions the human body in terms of the machine', then this extends to non-humanoid robots.[65] Robots like Paro rely on intersubjective norms and standards articulated in terms of reciprocity to the human body, and always incorporated into the human bodies with which the robot interacts. Robots, of course, do not need to be designed to be reciprocal to humans. It is possible to develop robots in ways that cultivate their alterity, especially in terms of their distinctive sensors and perceptual processes. Kathrine Hayles notes the development of sensors that 'can adapt and evolve independently of the epistemic categories of the humans who create them', and Claudia Casteñada points out the feminist potential of conceiving of robotic bodies as a kind of perceiving skin that exceeds the morphology of the human.[66]

Demanding expression and decontextualised feeling

Paro's employment of the embodied imagination illustrates the capacity of the expressiveness of social robots to regulate and intervene in our imagination. In a normative fashion or otherwise, such influence can potentially disrupt or overly control the self's associations. Social robots do not have to unduly control the imagination, and this is certainly desirable for some purposes—for example, for children's toys or caregivers.[67] Robotic artworks have communication as a primary function and are a form of social robot that shows robots' potential to engage in open-ended and creative interaction. In contrast to Paro's aim to prudently circulate a comfortable, positive affect, a robotic work of art such as Louis Phillipe Demer's *Blind Robot* aims to provoke potentially uneasy questioning in its interlocutor about

62 Pearson and Borenstein, pp. 23–31.

63 Eleanor Sandry, 'Revaluating the Form and Communication of Social Robots', *International Journal of Social Robotics*, no. 7, 2015, p. 344.

64 Suchman, pp. 119–45; Pearson and Borenstein, p. 244.

65 Alač, p. 496.

66 Hayles, p. 140; Claudia Casteñada, 'The Future of Touch', in S. Ahmed and J. Stacey (eds), *Thinking through the Skin*, Routledge, 2003, p. 233–4.

67 For example, children's caregivers need to facilitate a child's cognitive, physical and social development. Borenstein and Pearson further point out that 'care is not the same for each person or at each life stage', p. 255.

interaction and feeling between robots and humans. Its direct and open expression—using two robotic hands to feel the face of its audience before translating this information into a portrait—provokes unanticipated thoughts, feelings and responses in its audience such that they must synthesise their own meanings (as one would hope a work of art does).[68]

The greater persuasive power of physically present robots compared to animated or imagined figures is evident in research into differences between physically embodied, virtually embodied and virtual agents.[69] As homes are filled with expressive robots to support people's dieting, remind them to take their medication and inform them of the weather, it is possible that their affective demands sit uneasily in the context of people's everyday lives and serve questionable ends. In the case of Paro, the purpose of the device in its therapeutic form is to encourage positive affect in patients with dementia, and the employment of the imagination in a normative and restricted fashion—so as to provoke minimal unexpected reactions—is appropriate to this task. In this instance, the generation of positive feelings generated via the tactile imagination is part of a therapeutic process central to improving the patients' everyday lives. But feelings elicited by robots are not always so carefully or altruistically situated within the structure of people's lives.

Merleau-Ponty's account of expression and feeling suggests why casual, decontextualised provocation of strong feelings may be problematic. He views all feeling as genuine, writing: 'Illusory or imaginary emotions [so-called] are genuinely experienced, so to speak, on the outer fringes of ourselves.'[70] What might be described by some as a false emotion is for Merleau-Ponty an emotion that is insufficiently embedded in a person's being or in the broader structure and behaviour of her life. This suggests, for example, that the issue encountered when children bond with and fret over robotic toys, as described by Turkle, is not that they are experiencing illusory feelings, but that the robotic toy cultivates overly consuming feelings about a relatively trivial toy, feelings that are powerful but inadequately embedded in a meaningful structure of a child's life.[71] Conceived this way, concerns about the capacity of social robots to provoke strong, caring feelings relate to their ability to place trivial, undesirable or oppressive concerns persistently at the centre of the self in an intrusive, controlling or cluttering way that disrupts processes by which the embodied self generates meaning. This goes not only for negative affects but also positive ones. As Sara Ahmed has convincingly shown, simply because an affect is positive does not mean it should be embraced, because affects are part of broader cultural-political economies and need to be investigated for the roles they play there.[72]

Drawing on the example of the therapeutic robot Paro, this article began by showing how feelings are provoked by processes of perception and expression occurring in human–robot interactions. It then considered the way these processes are driven by an embodied and social imagination, and the implications of the reversibility of the perception of social robots. While the human incorporation of machines is often conceived in terms of mechanical elements being actually implanted in human flesh, here we see how post-human corporeality incorporates the machinic via the embodied imagination. Interaction with Paro is about

68 *The Blind Robot*, http://www.processing-plant.com/web_csi/index.html#project=blind

69 Jamy Li, 'The Benefit of Being Physically Present: A Survey of Experimental Works Comparing Copresent Robots, Telepresent Robots and Virtual Agents', *International Journal of Human–Computer Studies*, vol. 77, 2015, pp. 27–37.

70 Merleau-Ponty, *Phenomenology of Perception*, p. 443.

71 Turkle, pp. 23–147.

72 Sarah Ahmed, *The Promise of Happiness*, Duke University Press, Durham, 2010, p. 2.

'experiencing the structure and mechanics in one's own body'.[73] Continuous with expressive practices and objects to which we are more accustomed, such as films and videogames, the sensations, emotions and feelings promoted by robotic interactions are embedded in culturally and historically specific bodily practices. As producers and products of these practices, social robots require scrutiny for the embodied imaginaries they employ to engage feeling, and the bodies and selves they produce.

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73 Alač, p. 522.

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