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# Affective Movement in Robotic Art: Alternatives to the 'Interiority Paradigm' in Social Robotics

**Irene Alcubilla Troughton,** Media and Culture, Utrecht University, NL, i.alcubillatroughton@uu.nl

This paper critically evaluates how emotional and intentional movement is conceptualised and deployed in social robotics and provides an alternative by analysing contemporary robotic artworks that deal with affective human-robot interaction (HRI). Within HRI, movement as a way of communicating emotions and intent has become a topic of increased interest, which has made social robotics turn to theatre and dance due to the expertise of these fields in expressive movement. This paper will argue that social robotics' way of using performative methods with regards to emotional movement is, nonetheless, limited and carries certain challenges. These challenges are grounded on the claim that social robotics participates in what the author calls an 'interiority paradigm'. That is, movement is understood to be the expression of inner, pre-determined states. The 'interiority paradigm' poses several challenges to the development of emotional movement, with regards to unaddressed human and robotic imaginaries, an emphasis in legibility and familiarity, and a restrictive interior/exterior binary that limits the role of movement in an affective connection. As an example of how robots could be imagined beyond this interiority paradigm, the author proposes to turn to contemporary robotic art. Robotic art's view on affective movement as a matter of evocation and of performative co-creation might inspire the development of robots that move beyond the requirement of being mere copies of a human interiority. While the intersection between robotics and the performing arts is a fruitful field of research, the author argues in this paper that the way in which movement is currently being developed through performative methods has certain shortcomings, and that the perspective of robotic art on affective movement might open up a more interesting area of exploration for social robotics, as well as expose those aspects of theatre and dance that have being unaddressed in robotics.

## I. Introduction

Social robotics, the field that focuses on how autonomous robots interact and communicate with other autonomous agents following social behaviours, is gaining increasing interest in other areas, such as philosophy (Seibt, 2018), dance (Jochum & Derks, 2019; Lourens et al., 2010; Salaris et al., 2016) or theatre (Jochum et al., 2016; Knight & Gray, 2012). Especially the area pertaining to human-robot interaction (HRI), due to its dependence on studies about human-nonhuman communication, has been a site of exploration for scientists, humanities scholars and artists alike. In recent years, social robotics has paid attention to movement as a means to complement more traditional and costly approaches to HRI, such as anthropomorphic appearance or communication through symbolic language (De Wit et al., 2018; Van Dijk et al., 2013). The exploration of movement as not only functional and pragmatic but also as a key component in making an agent seem intentional or emotional is one of the main directions through which social robotics tries to achieve a more effective communication and collaboration among humans and robots (Barakova & Lourens, 2010; Hoffman, 2014).

The idea that expressive motion can improve HRI, that recognising and responding to emotional and intentional movement is a vital part of connecting among autonomous agents, has made social roboticists turn to theatre and dance due to the expertise of these fields with regards to expressive movement.[1] While the intersection between robotics and the performing arts is a fruitful field of research, I will argue in this paper that the way in which movement is currently being developed through performative methods has certain shortcomings, and that the perspective of robotic art on affective movement might open up a more interesting area of exploration for social robotics, as well as expose those aspects of theatre and dance that have being unaddressed in robotics.

## II. Social robotics and the performing arts

### *A. Theatre and dance in social robotics*

Several methods from theatre and dance have been employed in social robotics with the goal of developing and responding to emotional movement in interaction with humans. Even if the range of examples is wide, they can be categorized in the following clusters:[2] Firstly, the creation of dramatic characters. Movement here supports the creation of dramatic characters, which is intended at sustaining social interactions (Simmons et al., 2011), promoting acceptance (Anzalone et al., 2010; Jochum et al., 2016) and effectively responding to human social cues while showing intentionality (Breazeal et al., 2003). These projects tend to use theatre as a testbed, for dramatizing

concerns (Breazeal et al., 2003; Jochum et al., 2016; Lemaignan et al., 2012) or for feedback on early prototypes (Chatley et al., 2010; Syrdal et al., 2011). Other projects, however, instead of aiming at the creation of a performance, employ those dramatic characters to design robots that function in the wild. This is usually the case of robots that work in public spaces offering a service to humans, such as receptionists or guides (Anzalone et al., 2010; Meerbeek et al., 2009; Simmons et al., 2011). Movement in these projects, therefore, serves the purpose of developing characters in robotics, as it is understood that through movement and behaviour, robots can express personal traits and consequently show a particular personality.

Secondly, the use of acting methods. In a similar vein, and closely related to the creation of dramatic characters, Guy Hoffman (2016), as well as Heather Knight and Matthew Gray (2012), have focused on acting methods as a way of incorporating theatre in the design of social robots. Heather Knight and Matthew Gray have experimented with Chekhov's psychological gestures and Guy Hoffman relies mainly on Stanislavski for his designs. In both methods, as it happened with the previous section, the authors rely on an interpretation of dramatic characters in which motive or intent drives expressions.

Thirdly, dance notation systems. Some studies try to achieve the development of emotional movement in robots by means of the notation system that Rudolf Laban developed, particularly LMA (Laban Movement Analysis). LMA provides the tools to analyse how emotional movement patterns are enacted in humans and, according to the roboticists following this method, it gives the basis to later on implement those patterns in robots (Abe et al., 2017; Bacula et al., 2020; Barakova & Lourens, 2010; Ikeuchi et al., 2018; Knight, 2014; Knight & Simmons, 2015; LaViers et al., 2017; Rett & Dias, 2007; Sharma et al., 2013; Wallis et al., 2010; Zhu et al., 2019). The goal of the projects greatly varies, but there is a common intention in most roboticist interested in Laban. Normally, Laban notation is employed to analyse how humans convey emotion through bodily movement and how that movement can be programmed in humanoid robots. Movement here then is also used as a means to express inner intentions and emotions; it is understood to be the channel through which an interiority is expressed.

Finally, improvisational techniques. The most common way of using improvisation in social robotic projects is with a goal-oriented approach. Furthermore, this approach is usually combined with an understanding of improvisation as based on the existence, and later expression, of internal states. To say it differently, this vision of improvisation implies an autonomous sentient individual who is moved by internal states which are then expressed in movement. This can be seen in two types of projects. Firstly, in projects that try to program specific personality characteristics in robots that seemingly direct their decisions in improvised settings (Bruce et al., 2000; Magerko et

al., 2010; Meerbeek et al., 2009; Skeppstedt & Ahltorp, 2018). Secondly, in projects that understand improvisation from an internal perspective, inasmuch as it is considered that the somatic and embodied knowledge that permits the improvisational act are located in the inner sphere of the human individual. These projects, therefore, require human beings to access such bodily knowledge through improvisational practices and then apply it to the development of robots or use it to tele-operate robots in improvisational settings.

In two interesting cases, however, movement is employed as a way of becoming responsive and spontaneous in an interaction with others and the environment (Jochum & Derks, 2019; Wallis et al., 2010). In these experiments, the role of movement in HRI was that of an embodied conversation, rather than a tool to access an interiority. These types of experiments, nonetheless, are scarce.

### *B. The role of movement in HRI*

As we have seen in the previous section, most social robotics participates in what I will call an 'internal paradigm' with regards to movement. That is, in these projects, movement is understood to be the expression of inner, pre-determined states. This is based on the following assumption: humans are psychological beings that feel and later express inner states (emotions, intentions, drives, etc.) through movement and behaviour. As robots are not psychological beings but need to resemble human beings in order to connect with us, goes the logic in these projects, they need to copy human expressive movements.

Even if some research in social robotics, such as the experiments focused on proxemics, deal with a non-internalist perspective on movement, the intersection of robotics and performing arts, especially when directed at developing emotional and intentional movement, tends to pivot towards this internal paradigm. With this, I am not claiming that every research falls into this paradigm, but rather that there is a great tendency to hold this view of movement. Exploring affect through bodily engagement is an interesting and useful area of research for human-robot communication which should not be merely discarded. However, it is important to address the assumptions and challenges that lie behind this interiority paradigm and find alternatives within the area of affective movement and bodily communication. Performative methods can aid in doing so, but not in the way in which they have been mostly used in social robotics. In the next section, therefore, I shall pinpoint the challenges that the 'interiority paradigm' poses. Following that section, I will move to robotic art as a less acknowledged part of the performing arts which deals with a different understanding of an embodied affective communication between humans and robots.

## III. Problematics of the interiority paradigm

The interiority paradigm poses three main challenges to the development of affective movement in HRI: firstly, it is based on a, often unaddressed, particular imaginary of a human being, and consequently an imaginary of robots. The human within this imaginary is conceptualised as a psychologised entity that possesses inner states, has access to them and can express them in movement and behaviour, in the way that they desire. But also, as someone who can conceal their feelings, should they want to do so.

Cynthia Breazeal's social robot Kismet has been according to many scholars a paradigmatic case of how a determined conception of the human is linked to the expression of emotions. Kismet is one of the first social robots that focused on emotion recognition and expression as a means of HRI and one of the most influential in subsequent experiments. That is the reason why current scholars have turned a critical eye to Breazeal's work and have tried to unpack the underlying assumptions and history of emotions that support the development of both Kismet, as well as more contemporary social robots that follow this type of emotion implementation (Atanasoski & Vora, 2019; Rhee, 2018; Suchman, 2004; Treusch, 2021). The main problematics of the current way of programming emotions in robots, these scholars argue, is that such an understanding is based on a history that, especially during the 20th century, argued for the universality of emotions across humans and aimed at a clear-cut classification of emotional states. Furthermore, influential texts in the history of emotions as, for example, Darwin's *The Expression of the Emotions in Man and Animal* (1872), also create a boundary between so-called 'civilised people' who are able to control and conceal their emotional display and 'uncivilised people' who, on the contrary, are only able to display emotions transparently.

This connection between current social robotics models of emotion recognition and expression with discourses that in the early 20th century made such claims about the universality of emotions, as well as the interplay between transparency and concealment, needs to be considered. As Schuman asserts, such categories of emotions were mapped in a way that often permitted highly unethical comparisons across gender and race, creating an 'economy that circulated through, but was discursively separable from, specific bodies' (Suchman, 2004, p. 5).

Furthermore, as Atanasoski and Vora (2019) point out, in this paradigm, human exceptionalism is at play, as robots are designed to mimic human emotions in a simulation that keeps humans in the apex of evolution: "the position of the robot is always inferior because it must perform affect transparently, and therefore cannot perform proof of the hidden interior psyche that would indicate equality to the human" (2019, p. 110). Such an imaginary is therefore embedded in histories of racial and gendered discrimination, in which less than human or non-human others are devalued

in terms of their inability to control/conceal inner states, or the fact that they lack a complex interiority.[3]

Secondly, the interiority paradigm assumes that for a successful communication and connection to take place, similarity is needed. As Jennifer Rhee (2018) has pointed out, familiarity has played a key role in the development of social robotics, as evidenced in two of the most relevant texts about HRI to date: Alan Turing's test and Masahiro Mori's 'Uncanny Valley'. According to Rhee, both texts point at 'familiarity' within HRI as the essential border (sometimes challenged and sometimes reinforced) at which the difference human/non-human can be enacted. I would like to argue that familiarity as a concept is closely related to the idea of similarity: that which we identify as equal and as known, that which we take for granted in its resemblance to us and our habits.

In HRI, as shown in its endless interest in humanoid design, similarity is considered as a core value in the relationship and possible connections between humans and robots. As Pat Treusch rightfully highlights, social robotics articulate "the current hegemonic understanding of the socially meaningful robot as necessarily human-like" (2021, p. 10), an assumption that largely goes unquestioned. However, uncritically leaning towards humanoid design and anthropomorphisation influences not only physical appearance but also the type of behaviour that is enacted. In what pertains to emotions, and based on this universalised idea of a 'human', social robotics opts for the programming of clear-cut and well-defined emotional states that are enacted through the performance of specific human movements and behaviours. This reduces the role of the robot as that of a human copy, therefore foreclosing material and ethical approaches to the importance of otherness and diversity, but also restricting the possibilities of exploring behaviour as emerging from the material affordances of the robotic platforms. Furthermore, it reproduces, rather than challenges, the imaginaries of specific individual experiences turned universal.

Thirdly, it treats movement only as a medium, as a mediator of an interior that is supposed to precede and be of more importance than the movement itself. Therefore, there is a clear interior/exterior dynamic that is not addressed and does not account for other conceptions of movement, such as embodied approaches to cognition. In this paradigm, consequently, human emotions are considered to be internal states that only at a later stage get expressed through movement and behaviour. The goal of robotics therefore is to properly divide and program this translation of interior states to external expression. In this scenario, emotions are understood to be discrete, measurable entities that can be recognised, analysed and programmed, and the role of movement is relegated to that of a mere mediator between psyche and outer world. This is also influenced by an informatics conception of communication where the message

is either correctly delivered or fails to be conveyed, and where the body is a mediator distinct from the mind.

## IV. Affective movement in robotic art

As an example of how robots could be imagined beyond this interiority paradigm, I propose to turn to robotic art, and the way in which this field deals, in a performative setting, with affective movement. Robotic art, a field that seems to be at a crossroad between visual arts, performing arts and theatre, points at the potential of theatrical and performative aspects that have not yet been addressed by social robotics.

Although the history of robotic art has not been widely researched, several accounts, usually made by practitioners themselves, have given a hint as to what are the main interests of such a field (Kac, 1997, 2001; Penny, 2013; Stelarc; Herath, D.; Kroos, 2016). The beginnings of robotic art, a term coined by Eduardo Kac, are roughly positioned in the 50s or 60s, with two main influences: kinetic art and cybernetic discourses.

Kinetic art, with its focus on movement perception and context as means of creating sense of the work of art, highly influenced robotic art (Demers & Horakova, 2008; Kac, 1997). The way in which the robot, through its engagement with the space and the people around it, evoked certain concepts and affects, became therefore the focus of such projects. This interest in interactivity and feedback loops also arose from the cybernetic discourses of the time.

Cybernetics, an interdisciplinary field of research that was founded around the 1950s and especially through the work of Norbert Wiener and the Macy Conferences, started to pay attention to the relationships between agents and their environment. The first wave of cybernetics defined this relationship in terms of information-processing systems which tended towards homeostasis or stability. Another strand of cybernetics, part of the second wave and initiated by Heinz von Foerster, however, introduced concepts such as reflexivity (and in some more extreme cases like that of Maturana and Valera, 'autopoiesis') as essential in considering not only feedback loops but also the relationship between information, context and meaning, as well as the role of the observer (Hayles 1999). This line of thinking was followed by author and artist Gordon Pask, whose *Colloquy of Mobiles* became a reference for robotic art, and thinkers such as Gregory Bateson.[4]

Early robotic artists found in this type of cybernetic discourses an interesting contraposition to the ideas that were being developed by the field of Symbolic AI. Simon Penny, one of the main figures of robotic art, asserts: "Cybernetics was involved with the idea of intelligence as located in and evidenced by the integration of an agent

with its world, whereas symbolic AI was concerned with the notion of intelligence as constituted by manipulation of symbolic tokens occurring in an abstract immaterial space of logico-mathematical representations, be that space in a brain or in a machine" (Penny 2013, p. 151).

Symbolic AI was highly influential in the field of both artificial intelligence and robotics until approximately 1990, where other strands of social robotics, such as Rodney Brook's situated robotics, began to take shape. However, as several scholars have pointed out (Rhee, 2018; Schumann, 2004), situated robotics kept on relying on an exterior/interior divide where the role of body and movement was still a secondary appendix to the importance of the mind. Furthermore, as it has been explored in the previous section, even if contemporary strands of social robotics pay attention to embodiment and its relation to the environment, the expression of internal states keeps on being at the forefront of most experiments. The prevalent conception of communication between humans, or humans and robots, keeps on being thus connected to an information process where movement becomes a medium that needs to convey a clear and transparent message.

In opposition to this, robotic art was inspired by the strands of cybernetic thinking that moved away from notions of communication as the transmission of a clear message. They, in turn and through the material exploration of their own creative work, were researching other modes of communicating in which meaning emerged from the engagement between several conversational partners (Sandry, 2016). A relevant artwork in this respect is Nicolas Schöfer's *CYSP 1,* which, according to Kac (1997), marked the transition between kinetic art and robotic art. This piece, made in 1956, had sensors that produced movement in response to the presence of observers, consequently opening the road to the following robotic artworks that were developed. Since then, several key pieces saw the light, such as *The Senster* by Edward Ihnatowicz, *Petit Mal* by Simon Penny, *Squat* by Shuya Abe and many more, that focused on the principles of interrelationships, embodiment as an essential characteristic of communication and interaction, and also otherness as something to embrace rather than subsume.

Robotic art, therefore, proves to be an area of artistic research that moves away from the assumptions behind symbolic AI and current social robotics. On the one hand, robotic art focuses on the processes and functions of technology, and the way in which it could afford communication and affect, rather than on its human-like appearance and its reliance on human-like models of behaviour. On the other hand, it relies on interdependencies, situatedness and the value of otherness in order to establish an affective connection. In this sense, then, robotic art does not consider similarity and familiarity as a vital part of communication but explores how other modes of engagement can happen within alterity.

In what follows I shall describe two main strategies that can be found in robotic art and that conform a different approach to affective HRI than that of the internal paradigm in social robotics: evocation and performative co-creation.

### *A. Evocation*

Robotic art approaches affective movement from a different standpoint than that of the expression of inner states. Instead, movement is considered from the point of view of what it evokes. That means that rather than focusing on specific psychological states (emotions, intentions, and so forth) as that which needs to be expressed through specific behaviours, the viewer's perception of movement is the focus of these projects.

This creates an interesting shift from the interiority paradigm for two reasons. First of all, movement is understood to be part of a bigger system of meaning that also encompasses context, scenography, narrative, as well as previous preconceptions held by the public. In such an understanding, the meaning of movement is not associated, as a later by-product, with an inner state experienced by an individual, but is inseparable and emerges from the situation in which it takes place. Secondly, it foregrounds the malleability of movement interpretation rather than univocally associating inner states with particular (human) expressions. Such a view then displaces the psychologist interpretation of movement, refuses to hold on to ideas of universality and transparency in expressive movement but also moves away from mimicry or imitation, because movements that are not identical or even similar to that of human beings can, nonetheless, still evoke specific qualities that can be interpreted and understood by the audience.

*Fish-Bird* (2004) by Mary Velonaki can serve as an example. In this robotic artwork, two wheelchairs move around a room, in response to the audience through sensors, while dropping printed letters to each other with different messages, most of them of a romantic nature. These robots, which do not follow anthropomorphic or zoomorphic shapes, nor depict human-like behaviour and movement, are able to create an affective intimacy with their public. This is achieved mainly through the staging of the interaction and what their movements, in combination with the situation and the printed messages, afford to interpret. A very interesting aspect of this work is, furthermore, the fact that Velonaki foregrounds not only human connection to these machines, but also the affective engagement and communication among the robots themselves. This sort of machine communication, however, does not rely on transparency or a clear delivery of information. On the contrary, rather than depicting turn-taking interactions, *Fish-Bird* exposes a flowing and overlapping mode of communication that allows for co-regulation to emerge (Sandry, 2016). The meaning of such an interaction comes to the fore through the movement of the robots,

their engagement with each other and the audience, and the context in which they are embedded which includes, among others, the printed letters, the scenography, and the place where this interaction occurs. Furthermore, our access as human participants to this non-verbal communication is merely partial and does not depend on the correct deciphering of their movements in terms of their initial intentions. Rather, the spectators engage affectively with the ongoing interaction on the basis of what their movements evoke in their setting.

Another example is to be found in Bill Vorn. Vorn commenced in 2006 his series called *Hysterical Machines* (2006), composed of eight-legged robots made of aluminium in environmental installations. Hanging from the ceiling, these creatures are immersed in a space crafted with sound and light and are equipped with sensorimotor systems, which allow them to perceive the surroundings and react to them. The machines shriek and convulse in presence of the audience, but do not always react to the humans that visit the exhibition, keeping a reactive but, in a way, alien system. This, moreover, creates a mismatch between robotic movement and human expectation which undermines the univocal and universal association of inner states to external expressive movement, as the public is not always able to identify why certain machines might move and react as they do. The actions performed by those creatures suggest dysfunctional, absurd, and deviant behaviours (Vorn 2014), and frame the visitors in the position of intruders or even guilty parties in the suffering of the machines. The name of the exhibition therefore only gains meaning when understood from the perspective of what that machinic movement evokes in the audience. Furthermore, by focusing on motion that moves away from the ideals of productivity, transparency and similarity in robotics, *Hysterical Machines* is able to create an affective connection in dysfunction.

### *B. Performative co-creation*

Robotic art's approach to affective movement foregrounds that such an embodied communication takes place in the in-between; that is, in the moment of the encounter. In order words, robotic art treats affective movement as performative, inasmuch as the affective states that arise in the encounter are co-created by humans and robots alike. Furthermore, in some of these performances, affect is conceptualised as a coupling of movement dynamics that does not require a clear communication of a message nor a deciphering of intentions. That is, their movement dynamics are co-created by the entity human-robot, and do not reflect pre-existing internal emotional states, which undermines the mind-body distinction in HRI, as well as the imperative of imitation for an affective communication to take place.

An early experimentation of this sort of human-technological engagements can be found, of course, in Stelarc and, for example, his paradigmatic project *The Third Hand* (1980). In this artwork, a robotic third hand is attached to his body as an extra limb, in contraposition to how a traditional prosthesis would replace a part of someone else's body or someone's bodily function. An early pioneer of cyborg art, Stelarc might at times seem to endorse transhumanist approaches by his interest in 'extending' human's capabilities, or his hints at 'evolution' or 'body augmentation'. However, when inspecting his projects at a closer look, one might perceive how his understanding of human-machine attunement is more nuanced and involves the de-centering of humans in order for that engagement to take place. This is evident in Stelarc's description of his artworks in terms of invasion, of hosting and of relinquishing control. As he himself poses, 'the body can only perform effectively with a posture of indifference – as opposed to expectation'.[5] This quote brings up an interesting attitude towards human-machine relationships, as it implies that humans must step aside from both their role of model as well as judge of such technology, and instead take a semi-passive step in adapting themselves to machines. Robotic devices in Stelarc's work then, in their close connection to the human body, enact their own type of agency in a way that requires humans to step out of their own expectations of such technology and give in to a new type of connection where humans do not hold all the power. As Joanna Zylinska (2002) rightfully asserts in her study about prosthetic art, Stelarc radically abandons the idea of self-possession and self-mastery in order to open up a new path for an encounter with technology.

A more contemporary example of this is explored in the work of Marco Donnarumma. Donnarumma is a performer and scholar who works with technology, music and performing arts, and critically engages with disability, posthumanist and gender studies. This is especially recognisable in his '7 Configurations Cycle' (2014), where each work exposes a type of embodiment deemed by him as a 'configuration'. A configuration is an organisation of human bodies, robotic hardware, machine learning software and microorganisms that affect each other. One of the pieces in this cycle clearly exposes the idea of performative co-creation: *Eingeweide*. In this show, two dancers, one robotic prosthesis and one microbial cloth appear on stage. Of special relevance is Marco Donnaruma and Amygdala, the robotic prosthesis that is attached to his face during the show. Amygdala has neural networks that are adaptive to its surroundings, and thanks to its sensing system, it can react to external stimuli, such as touch, pressure, or torsion. Also, as Amygdala is installed in close connection with Donnarumma's body, especially on his face, this contact is what permits these two bodies to coordinate their movements. This coordination takes place as a mode

of, in Donnarumma's words, 'automaticity'; that is, a transitional process where consciousness drops off and a certain threshold is surpassed that allows humans to get in contact with technology in a form of hybrid entanglement. In this automaticity, then, body and robotic prosthesis remain distinct entities, but are attuned in a form of pre-reflexive coordination that creates the emergent movement and, at the same time, reconfigures their original bodies. The encounter, different each time and marked by the specificities of the performance, creates a mode of physical and affective attunement where human and machinic body need to engage in a coordination, in a coupling, rather than a mimicry of each other's movements.

A similar exploration of coupling, but under different premises, is explored by Chryssa Varna in her 'Industrial Improvisation Project'. This artwork comprises one human dancer and two Universal Robot Arms with two big, white fans attached to them. The project aims at investigating the possibilities of non-verbal connection between humans and robots, as well as the creation of a set of emergent movements that do not rely on pre-programmed behaviours nor on imitative models. In order to do so, Varna employs structured improvisation techniques from William Forsythe and Ewan McGregor, which serve as a common ground for humans and robots. What is relevant in this case is that such common ground is not based on a human-centric dance style but relies on geometrical and spatial rules. This artwork focuses therefore on a type of improvisation that follow a set of adaptative rules, where each human and non-human performer needs to use continuous feedback in relation to the environment and use it to co-create with the other performers a set of emergent movements. This non-verbal connection between humans and robots, therefore, is not made through mimicry, nor through the deciphering of inner states.

## V. Conclusion

The performing arts offer a rich field of knowledge and practice within the area of non-verbal communication that can be of incalculable value to human-nonhuman encounters. However, the way in which theatre and dance methods have been employed in social robotics tend to be associated with certain unaddressed ideas about what human beings are, what robots should be in order to connect with us, and the role that movement plays in such an interaction. These assumptions have been conceptualised under 'the interiority paradigm' which, as I have explained, carries not only several problematics but also forecloses the creative approaches that the performing arts can bring to social robotics.

With these examples of robotic art, I have tried to show the possibilities that lie within the performing arts but that have not yet been fully addressed by social

robotics. These possibilities have to do specifically with how these robotic artworks see movement, the role that it plays in communication and how it can be explored in non-human embodiments. This can be summarised in three aspects:

Firstly, movement, in contraposition to the interior/exterior divide seen in the interiority paradigm, is not reduced to the expression of pre-determined inner states but constitutes a way of gaining bodily knowledge, as well as of engaging and connecting to the world and others. This can take place without the need of symbolic communication, conscious reflection, or inference as we have seen in the artworks that deal with performative co-creation.

Secondly, movement is not understood to express universal and transparent truths about an inner emotional life, but is shown as malleable in its interpretation, and therefore highly depending on its context, its environment and the point of view that's foregrounded in the representation of the human-machine encounter. The performing arts, as exemplified by the robotic artworks that focus on evocation, also offer the possibility of creating spaces where the meaning of a non-verbal interaction is not taken for granted, and where robotic movement can be open to multiple interpretations.

Thirdly, movement is not only associated with human corporeality and expression, but it is also explored in non-human embodiments. All these artworks therefore begin from the materiality of the object at hand and evaluate its possibilities for movement and embodied connection beyond the mimicking of human behaviour. In this way, new modes of approaching embodied communication can take place while, at the same time, trying to avoid the reinforcement of human stereotypes and expectations.

To sum up, the contribution of this paper is two-fold. Firstly, it points to the shortcomings of the present view on emotional movement that is held at the intersection of performing arts and social robotics. Secondly, it suggests the perspective of robotic art as an alternative to the current panorama, which opens new interpretations of what theatre and performance have to offer to social robotics. Robotic art's view on affective movement as a matter of evocation and of performative co-creation might, therefore, inspire the development of robots that move beyond the requirement of being mere copies of a human interiority.

## Notes

[1] Note that when I talk about robotic projects, I use the term 'emotional movement' and when I address robotic art, I employ the term 'affective movement'. A full account of the differences between these two concepts is out of the scope of this paper, but I chose to keep the distinction to foreground the different perspectives that these two areas propose, being the first one more inclined to think of affect in terms of internal, clear-cut and individual emotions.

[2] Other projects have used techniques from puppetry or have focused on the creation of robot choreographies or robot comedy shows, and in some notable cases, there is an interesting shift from the interiority paradigm that I propose. However, as these projects do not focus on movement as a means of analysing, expressing and/or responding to emotional cues, they have been left out of this literature review.

[3] This aspect has been, in a similar way, criticized by Mingon and Sutton (2021) under the name of "Western internalism". These authors claim that such a perspective of an individual, internal and bodily-separated mind justified forms of colonial justice and advocate for a 4E cognitive approach in order to overcome the same implications when working with robots.

[4] Gordon Pask became a major figure also in British cybernetics. His work, both theoretical and artistic, served thus as inspiration for both cybernetics and robotic artists. Of key relevance is his appearance in the famous Cybernetic Serendipity exhibition in 1968. His installation, the Colloquy of Mobiles, explored a dynamically evolving scenario with three 'female' robots and two 'male' robots that would emit and reflect light, but also react to the flashlights and mirrors that the audience could use, as they would stop when the light input would hit a particular part of their embodiment. With this work, he tried to put into practice his own 'conversation theory': an emergent cycle of interrelations and meanings produced by humans and non-humans.

[5] Quote retrieved from http://stelarc.org/_.php [Accessed/10/2021]

## Competing Interests

The author has no competing interests to declare.

## Author Information

Irene Alcubilla Troughton is a PhD candidate at Utrecht University within the project *Acting Like a Robot*, where she researches what movement techniques in theatre and dance have to offer to the development of human-robot interaction and the design of robot behaviour. She holds two RMA degrees in Media, Art and Performance (UU), and Theory and Critique of Culture (Carlos III University). Other interests of her lay on embodied cognition, posthumanism, and critical disability studies.

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