Sabanovic S, Bennett CC, and HR Lee (2014) Towards culturally robust robots: A critical social perspective on robotics and culture. ***Proceedings of the ACM/IEEE Conference on Human-Robot Interaction (HRI) Workshop on Culture-Aware Robotics (CARS)*****. Bielefeld, Germany. In Press.**

Towards Culturally Robust Robots: A Critical Social Perspective on Robotics and Culture

Selma Šabanović
Informatics and Computing
901 E. 10th Street
Bloomington IN 47408
selmas@indiana.edu

Casey C. Bennett
Informatics and Computing
901 E. 10th Street
Bloomington IN 47408
cabennet@indiana.edu

Hee Rin Lee
Informatics and Computing
901 E. 10th Street
Bloomington IN 47408
hrl@indiana.edu

ABSTRACT
In this paper, we argue that cultural robotics should be grounded in a critical approach that acknowledges the co-construction of culture and scientific practice and technology design, as well as the dynamic nature of culture and its role in shaping human cognition and social interaction. We suggest this can be done in two ways: 1) by making the robot design process more culturally reflexive and inclusive of the perspectives of diverse stakeholders, and 2) by designing robots to be sensitive and adaptable to salient cultural values and practices, rather than designing robots for specific cultures. Building on these two key points, we suggest an approach based on *culturally robust* robotics.

Keywords
Human-Robot Interaction; Culture; Cultural Robotics; Robotic Design; Social Cognition

1. INTRODUCTION
Culture has only recently become an area of study in robotics, but research on culture has a long history in the social sciences, including anthropology, sociology, and psychology. Social studies of technology have also explored the role of culture in the design, adoption and use of technology, and the reciprocal influence of technology in cultural development and reproduction. Informed by such critical social approaches to technology and culture, this paper reflects on the ways in which culture has so far been addressed in robotics research and explores how social science frameworks and methods can guide further studies on the connections between culture and robotic technologies.

We envision culture as it applies to robotics as a complex and multidimensional concept. We suggest its study should be approached reflexively, to avoid the cultural essentialism that plagued early scientific engagements with culture in the social sciences, and the computational reductionism evidenced in attempts to introduce "the social" into robotics (See [43, 50, 51]). Consequently, to develop culture-aware robots, robotics researchers need to be not only aware, but questioning of cultural explanations, meanings, the mutual effects of culture and technology, and of the role that culture plays in human cognition and interaction. Robotic technologies, furthermore, should not only be able to identify and mimic cultural forms, but they should be *culturally robust* and adaptive to the dynamic and situated performance and experience of human culture and its role in shaping human cognition. We see a culturally robust robotics as allowing for critical reflection on dominant cultural values and the place of robotics in their reproduction, rather than simply computationally reproducing specific cultural patterns.

The paper is laid out as follows. In Section 2, we provide a critical analysis of how culture has so far been addressed in robotics. In Section 3, we discuss how those issues of culture and robotics relate to broader social science research on cultural phenomena. In Section 4, we link the cultural discussion to the study of scientific practice and technology design, as well as to situatedness, embodiment, and dynamics within modern social and cognitive science. Culture shapes how humans interact with their environment – technology included – but it does so through a lens of situated practice and cognition. That lens is a dynamic one, in which we are not only passive observers in our environment, but active participants in cultural contexts both as users and designers of robotic technologies. Robot design and human-robot interaction are thus part of a broader "system," system", a sort of *umwelt* [52] in a sense, grounded in situated action [50]. The development of culturally aware robots requires understanding this broader system and leveraging the interplay of culture, situated practice, and cognition to reflect how we already interact with and create knowledge about the world, technology, and each other. We propose this would lead to the development of a *culturally robust robotics*, which takes culture into account not only as a variable of interest, but as a holistic context in which robot design and use occur.

2. CULTURE IN ROBOTICS
2.1 Culture and Robotics in the Popular Imagination
The influence of culture on robotics, and of robotics on culture, has been a topic of discussion for decades, inspired by the global pursuit of industrial and scientific development. Particularly prominent have been discussions of the perceived cultural differences between the US and Japan, as two leading actors in the field. In the 1980s and '90s, Japan became known as the "Robotics Kingdom," inspired by the title of a popular book and the nation's success in industrial robotics [46]; more contemporary views depict Japan as a nation that "loves machines" in recognition of its focus on developing service robots for commercial use [24]. The idea that Japanese cultural traditions and emerging robotics technology are inherently tied is nurtured by the Japanese government, corporations, and scientists seeking to legitimize robotics, convince the broader public to accept robotic technologies for everyday use, and distinguish themselves

in the transnational scientific community and international technology markets [e.g. 25, 41, 43]. Critical scholars of robotics technology have pointed out that these attempts to naturalize technology through its connection to local culture can have problematic social consequences, including implicit support for conservative social policies [41], the reproduction of cultural stereotypes [16, 42], and "techno-Orientalism" [37], with Japan being described as both a source of awe-inspiring technological advancement, and a cultural "other," dehumanized through its "natural" acceptance of robotic technologies. These future visions, though popular, generally exclude the broader population outside of robotics labs from contributing to the definition of socially desirable and culturally meaningful roles for robots.

2.2 Culture in Robotics Science

Scientific interest in the influence of cultural factors on the design, adoption and use of robots has also increased with the globalization of robotics science and technology. Researchers make connections between cultural traditions and the design and use of robots, particularly contrasting the East and the West: animist beliefs have been used to explain the perceived comfort of Japanese and Korean populations with robots [18, 26, 27], while human exceptionalism has been suggested as a source of Westerners' discomfort with social and humanoid robots [18, 8]. Philosophical holism and dualism [26, 47], as well as individualist and communitarian social practices [44] have been identified as design patterns represented in the design of robots and potential human interactions with them. While these associations between culture and technology are compelling, as of yet little empirical work has been done to substantiate these cultural patterns and explore their meaning for the diverse set of actors implicated in robotics, including users as well as roboticists [42].

In addition to these generalized connections between culture and robotics, human-robot interaction researchers have been studying cultural differences in and effects on people's perceptions of and face-to-face encounters with robots. Bartneck et al [2] found significant cultural variation in negative attitudes towards robots among Dutch, Chinese, German, American, Japanese, and Mexican participants. MacDorman et al [33] showed US and Japanese participants have similar attitudes towards robots, suggesting factors such as history and religion may affect their willingness to adopt robotic technologies. Survey evaluations of the seal-like robot PARO by participants from Japan, the UK, Sweden, Italy, South Korea, Brunei, and the US found that participants generally evaluated the robot positively, but identified different traits as most likeable traits according to their country of origin [48]. In the context of human-robot teamwork, Evers et al found users from China and the US respond differently to robots [13] and that human team-members find robots more persuasive when they use culturally appropriate forms of communication [31]. Robotics researchers have also attempted to represent cultural practices computationally (see [44]), or computationally define cultural factors through observation (e.g. [40]) or with the aid of potential users (e.g. [39]) that can be applied to robots. These are examples of the growing body of work on cross-cultural differences in HRI and their potential design implications.

In the majority of such studies, the notion of culture as a distinct variable of interest is taken as a given, its meaning in different contexts rarely questioned, and few results show how culturally variable meanings of robots are constructed, or what kinds of effects the presence or idea of interactive robots has on related cultural categories, such as animacy, intelligence, companionship. We would argue this understanding of cultural awareness focuses on the behavioral level, and disregards the issue of meaning construction that is central to the study of culture.

2.3 Social Studies of Robotics and Culture

Social studies of robotics have taken up the job of addressing more reflexive questions regarding the interaction between culture and robotic technologies. Turkle [51] suggests that we are witnessing the development of a "robotics culture" predicated on the availability of socially interactive technological agents that can "do things *with* and *to* people." She considers the societal consequences of new robotic technologies not just for how we do things, but also for how we think about and experience our selves and social relationships, arguing that the unquestioning development and implementation of social robots has brought on a "crisis of authenticity" in social interaction. Suchman studies robotic technologies as cultural figurations, in which cultural themes are embodied, reproduced, and reassembled. She describes "autonomous, rational agency" as "the prevailing figuration of Euro-American imaginaries" of artificial intelligence and robotics and their role in society [50]. Šabanović shows both how robotics researchers implicitly reproduce cultural notions of sociality in robot design [44], and how Japanese researchers explicitly use notions of cultural specificity and fit to inspire and legitimize the development of socially interactive robots [42].

Popular imaginaries of robots, scientific studies of human-robot interaction, and critical social analyses of robotic technologies provide divers and somewhat contradictory views on culture and robotics. These interdisciplinary communities are rarely brought into direct conversation with each other or synthesized. This is partly due to their disciplinary incompatibilities – robotics researchers seek to computationally define and model culture so that it can implemented in robots, HRI researchers seek to develop an understanding of how cultural factors can be applied in robot design, and social scientists critique and problematize cultural categories in ways that not only make them more difficult to implement in technology, but put the whole project of cultural robotics into question. In an attempt to bring these different perspectives into conversation, we suggest *robotics as a culture-aware practice should incorporate an understanding of scientific practice itself as a cultural phenomenon and include the critical study of cultural meanings and values as they are defined outside of robotics labs into the development of new robotic technologies*. We suggest that this requires recognizing the need to study culture as a dynamic process, stepping out of the dominant knowledge hierarchy in which Western culture is normative and other understandings are "cultural," and actively seeking out and engaging the collaborative participation and input of potential stakeholders in developing a cultural understanding of robotics.

3. SOCIAL PERSPECTIVES ON CULTURE

Research on robotics and culture suffers from a problem endemic to all studies of culture – that "culture" seems omnipresent yet illusive, easy to identify in the abstract but difficult to address in specific instantiations. One reason for this is that we often become aware of culture as a difference from our expectations or a lack of shared understanding with others around us [20]. Studying culture and trying to define it through difference often leads, however, to stereotyping and using decontextualized cultural traits as static representations of dynamic experiences and meanings. When statements such as "the Japanese love robots" unquestioningly guide robot development, we end up reproducing assumptions that might not be desirable for future societies but can act as self-fulfilling prophecies—Japanese elders may indeed learn to love their robots because they have no one else to interact with. More complex understandings are needed to incorporate culture into robot design not only as an experimental variable, but as a fundamental aspect of human experience of the world. We suggest

social science viewpoints on culture can inform robot study and design with a more complex formulation of cultural phenomena.

3.1 Defamiliarization as method

Culture only becomes visible to us when something is not as it should be, so we approach culture as outsiders who need to work to understand the underlying logic of appropriate behavior and the meaning of things. Accordingly, scholars who study culture, including anthropologists of science and technology, often follow a process of methodological defamiliarization, in which they approach even their own cultures as new and unfamiliar, with assumptions that need to be analyzed not as individual parts but as an interconnected whole. Studying culture by leaving behind and questioning prior assumptions about difference and attending to its continuing construction has allowed scholars to develop more robust ways of understanding cultural experience. As Fischer [14] describes, this involves the understanding that "Culture is not a variable; culture is relational, it is elsewhere or in passage, it is where meaning is woven and renewed, often through gaps and silences, and forces beyond the conscious control of individuals, and yet serves as the space where individual and institutional social responsibility and ethical struggle take place" (p. 39). Culture is therefore not a set of patterns to be copied, but is in continuous development, and involves questions of ethical and social choice between multiple alternative futures.

3.2 Culture and power

Along with the notion of difference comes the understanding that culture and its study involve power differentials among institutional and individual actors [21]. This understanding was present from early scientific and political interest in culture in colonialist times, to later notions of cultural haves and have-nots, high and low cultures, dominant and sub-cultures, etc. In relation to robots, power differences are apparent in early depictions as Japan as a place where culture affects robotics (whereas it does not affect Western scientists), as well as in the agency which different people have in defining what counts as cultural difference. In the latter case, primarily researchers and in some cases the media and government have had the authority to discuss and construct the cultural meaning of robotics. The broader population, however, has so far been largely absent from the direct production of robotics culture, aside from inclusion in researcher studies about culture, which treat people as subjects from which cultural factors can be methodically extracted. A more robust cultural development of robotics should reflect on the power dynamics inherent in scientific work, and also seek to develop methods to overturn socially undesirable hierarchies such as those between researchers and users.

3.3 Culture as a relational phenomenon

It is widely accepted that culture is learned through social interaction, and shared by members of a community. Adopting cultural norms is part of becoming a social actor, and their knowledge and practice signifies group belonging. In some cases, such signification can come in the form of costly signals, such as a gang tattoo. As part of a learned and shared system of signification, culture is relational and enactive, in a continuous process of coming into being through the interactions of social actors (including technological artifacts). This relational understanding of culture suggests that particular parts or aspects of culture cannot be changed without affecting other parts—cultural meanings can change and affect technology, technologies can also be agents of cultural change. The relational view calls attention to the mutual shaping of culture and technology that should be taken into consideration in robotics development.

3.4 Culture is situated and dynamic

Early discussions of culture in the social sciences, as well as current discussions in robotics, often treat culture as a static entity – something that exists out there to be studied and which is a constant influence on thinking, practice, and technological development. Social research on culture has more recently shown that culture dynamically develops out of local, situated action (e.g. [49, 50]). Culture is therefore not a unitary and discrete variable to be manipulated for easier study or programmed into machines or people, as Hofstede [23] would have us believe; rather it is always characterized by multiplicities and performatively negotiated [14]. We can say that culture is "repeatedly assembled" [10] – certain core categories recur but are also dynamically adapted through time to fit contemporary circumstances, rather than being a direct copy of existing cultural and technological forms. Robotics therefore needs to take into account that the social meaning and practice of science and technology, the social roles of people and robotics technologies, and normative human responses to and relationships with these technologies and with each other across generations, artifacts, practices, and time, are constantly changing and adapting existing cultural models to new social and material circumstances.

3.5 Multiple levels of analysis

Culture occurs at the interplay between multiple units and levels of analysis nations, organizations, subcultures, disciplines, groups, individuals, etc. It is important to both motivate reasons for studying culture at a particular unit of analysis, as well as to be aware of the other levels at which culture operates and with which your own perspective inevitably intersects. One way to accommodate this multilevel view is to consider culture as being both "in the world" and "in the mind" [49] —taking the form of various practices, artifacts, and ideas that are publicly open and shared, as well as being enacted and understood in ways unique to individuals, who use them to make sense of the world. Culture can therefore be looked at as a cognitive model or schema that people use to interpret the world and that is shared at higher levels of organization, but also one that is constantly reinterpreted locally by individual actors within their own social networks and practices. In this understanding, robots can be studied both as physical instantiations and enactments of cultural patterns and meanings, and as artifacts whose meanings and uses are contextually malleable and situated, which needs to be taken into account in their culturally robust design.

3.6 Co-construction of technology and culture

Following the logic of the principles described above suggests that culturally appropriate technology development requires us to focus on co-construction of technology and culture, rather than one-way application of social and cultural representations in specific technological embodiments. Technology has long been discussed as a driver of social change in general and in robotics in particular – Brooks [8] sees it as a further step in an inevitable process of technological and cultural development, Gates [17] sees it as following the trajectory of the personal computer. History has, however, shown that the acceptance or rejection of technologies follow a socio-cultural rather than a purely technical logic, as when the Japanese refused to use guns because they did not fit their cultural understanding of combat, or in the decision by Amish communities not to use automobiles due to their potential negative impacts on the collective [38]. The development and adoption of technologies therefore need to be treated as social and cultural, rather than simply technical, choices.

4. STEPS TOWARDS A CULTURALLY ROBUST ROBOTICS

We look at the interactions of robotics and culture at different levels of analysis – *cultural discourse among roboticists* in the US and Japan, the expression of *culturally variable perceptions and understandings of robots among potential users* in the US and Korea, and investigations into *cognitive effects of context and culture on human-robot affective interaction* across the US and Japan. We see introducing cultural issues into robotics as an opportunity to reflect on the broader social situatedness and implications of robotics using comparative, enactive, and contextually situated methods to explore the co-construction of robotics and culture. We have also explored culturally variable interpretations of sociality, relationships, emotion, and other cultural dynamics as they relate to robotic technologies and human cognition. Such dynamics imply that robots need to be *culturally robust* both in their embodiment of cultural patterns and in the way the robot design process is approached as a cultural activity. Cultural robustness – going beyond cultural awareness – requires developing robots that can be adapted to and used in more than one cultural situation by being sensitive and adaptive to particular cultural factors. Cultural robustness also entails a robotics in which roboticists and users have a reflexive understanding of their own and technology's effects on culture while developing robots. Finally, a culturally robust robotics is not only concerned with developing robots that can be aware of culture, but also of training robotics practitioners and users who are reflexive and aware of their role place in cultural construction.

4.1 Co-construction of culture and robotics as a framework for analysis and design

As a foundation for developing a culturally robust robotics, we performed comparative studies of robot design and user preferences for robots in real-world environments across cultures. These studies explore the situated construction and interpretation of robots in specific contexts of use and the cultural logic of researcher and user perspectives on robot design and application to inform future robot design. We start from the observation that, in developing robots meant to act as social entities, roboticists and users construct not only technology but also future visions of social interaction, organization, and relationships that involve robots. Robots, in turn, function as material embodiments of "cultural imaginaries." [50]. Our first step toward a culturally robust robotics therefore starts from the critical study of cultural assumptions and factors affecting robot design and use.

To understand the cultural construction of robotics in scientific practice, Šabanović explored how *robotics researchers* in Japan and US have shaped robotic technologies based on their cultural backgrounds and assumptions. Using ethnographic methods, including participant observation and interviewing, and a comparative approach, Šabanović analyzed the cultural discourse and practice of social robotics in the US and Japan. She particularly focused on understanding how robotics researchers explicitly and implicitly construct different cultural notions of sociality, technology, its social roles and consequences in their discourse and practices. As part of this research, she also explored how Japanese robotics researchers explicitly use the notion of "culture" to legitimize their research, "repeatedly assembling" chosen cultural forms [42]. Examples include robotics researchers reinterpreting traditional dance as a set of computational instructions that enable the HRP-2 humanoid to dance, and developing "kansei robotics" using locally situated understanding of cognition that can be expressed through robot design and behavior. This research also shows that robotics researchers define users in culturally specific (and arguably stereotypical) ways represent them as likely to accept robots; examples here include expected consumption practices and culturally variable cognitive functioning about robots [42]. By addressing the broader cultural framing of robotics in a critical way, rather than as a given, this research opens up the possibilities for questioning and re-envisioning dominant ideas about robots and their use in relation to contested meanings of culture and technology. The comparison between the US and Japan is used as a critical move, showing that robot design is a matter of social choice rather than a technological inevitability and that alternative visions of robotics should be considered in light of their social consequences [43].

In order to open up further discussion and possibilities for culturally constructing robot design, we also explore how the cultural backgrounds of *robotics users* affect their expectations and interpretations of the meaning and use of robotic technologies in various contexts. We have been using a combination of qualitative and quantitative methods to study the attitudes and perceptions of potential users of robotic technologies in everyday spaces. A survey study performed with participants in the US, Turkey, and South Korea allowed us to identify cultural differences and similarities in user preferences regarding robotic technologies, particularly in terms of robot form, social role, intended users and acceptable contexts of use. The survey also empirically evaluated existing assumptions about salient cultural factors that might affect robot design, such as religious belief and exposure to positive and negative interpretations of robots in the media, and showed that such simple factors do not directly explain the cultural variability in user preferences, but that we need to a more situated and contextually based understanding of how users interpret and evaluate robotic technologies.

This line of research also aims to question the established power hierarchy between robotics researchers and users by giving users a chance to interpret robots and express their desires for robot design in their own words and in relation to the social contexts that matter to them. Findings from two generative design studies with participants in the US and South Korea, which asked users to think about robotic technology in their own homes, showed that user expectations and needs from robotic technologies are related to culturally variable conceptions of the home as relationally oriented in Korea and functionally defined in the USA [30]. In another generative study performed in South Korea alone, we discovered that technologies, including future automated home technologies, are interpreted in relation to the social roles and hierarchies of actors in the home and to the collectivist and individualist models of interaction in S. Korea and the US, respectively [29]. These findings identify cultural norms salient to robot design that researchers can follow, or potentially contest, when designing domestic robots (e.g. gendered hierarchy of work in the home as the context of robot use). They also allowed us to develop and test methods for including users as co-designers in the process of developing concepts for new robotic technologies, which can be used to ground design in a more inclusive understanding of social needs and cultural norms.

By analyzing and critiquing the cultural assumptions that researchers and users bring to robot design, we identify the ways in which culture and robotic technologies are currently co-constructed, ascertain contextually situated and salient factors behind specific designer and user preferences and expectations from robots, and also explore methods to increase user participation in robot design that will be necessary for the development of culturally robust robots.

4.2 Dynamic and situated understanding of culture and cognition

In ongoing work focused on the development of culturally robust capabilities for robots, we have also been exploring how cultural factors affect perception and cognition in human-robot interaction. There is a long-standing tradition in cognitive science that seeks to understand an agent's place in the world, and how that shapes the agent's epistemological and phenomenological constructs of "its world", its *umwelt* [3, 9, 52]. In living organisms, culture and cultural norms play a role in this shaping via cultural heteronomy [15]. The process is a dynamic one though, constantly in flux, and these dynamical properties afford particular opportunities for designing robots that adapt to their cultural environment [32, 34]

We recently conducted empirical studies in the United States and Japan of the interplay of context and culture in human perceptions of emotional facial expressions using a minimalist robotic face [5, 6]. The study involved both Americans and Japanese, as well as East Asians who were recent migrants to the U.S. The results suggested that context can override cultural differences in facial expression recognition. More importantly, the results support a dynamical systems view of social cognition as an emergent phenomenon, as suggested elsewhere [1, 11, 12]. For example, inducement of context effects could alter attractor states in human cognition, and thus fundamentally alter the interaction without necessarily altering the design of the robot itself [7]. Furthermore, preliminary results from an ongoing follow-up study suggest there are predictable patterns in the effects of congruent/incongruent environmental context on perceptions of robot affect across Western and East Asian individuals. In other words, taking advantage of context in the dynamical process of perception formation may ease the constraints for culturally specific affective cues in human-robot interaction. The goal is still to design robots in culturally relevant ways, but such an approach allows us to do so in a more flexible manner.

Research can also extend these dynamical aspects of social interaction to explore issues such as synchrony in human-robot interaction [36, 22]. Along these lines, further experiments are planned for this summer to expand upon previous work, exploring the role of temporal dynamics in human-robot social interaction and human social cognition. Studies in the U.S. and Japan will attempt to elucidate cultural differences in the coordination and rhythmicity of such dynamics. The dynamics of social interaction (or any interaction for that matter) entails a circular loop of perception and action over time, where the actions we take change what we perceive in the future, in the same way that perceptions may change the actions we take [35, 19]. Temporal modeling (e.g. Markov Decision Processes, reinforcement learning) can take advantage of this when designing algorithms for adaptive behavior [4], including robotic behavior [28], as well as patterns that may exist cross-culturally or in different contexts. Given that culture is dynamic and constantly in flux (see Section 3), it may not make sense to design robots *in toto* for specific cultures, but rather to design robots that are sensitive and adaptive to particular cultural factors, temporal ones included.

Alongside laboratory-based experiments, we are incorporating one of the robots (a robotic face) into a public art installation in April 2014, during which the same interaction will be studied in a "robots in the wild" experiment. As our prior research has shown, social and cultural factors can operate very differently in real-world settings, which necessitates such studies [45].

5. CONCLUSION

Our discussion of existing perspectives on robotics and culture showed that current research often relies on broad assumptions of cultural difference, and has not yet satisfactorily addressed the situated dynamics of cultural practice and sense making relating to robot design and use. We further suggest that more nuanced understandings of culture developed in the social and cognitive sciences, which depict culture as relational, dynamic, situated, and always related to issues of power and social choice, can be used to develop a more culturally robust, rather than merely aware, robotics. We argue that cultural robotics should ground itself in a more critical approach to the interplay of culture and technology by 1) making the robot design process more culturally reflexive and inclusive of the perspectives of diverse stakeholders, and 2) by designing robots to be sensitive and adaptable to salient cultural factors, rather than designing robots for specific cultures, because culture is dynamic and its role in shaping human cognition and social interaction equally dynamic. This entails studying cultural influences on researcher and user visions and interpretations of robots in specific social contexts, as well as the cognitive aspects of culture in human-robot social interaction, as displayed in our ongoing cross-cultural research in robotics.

6. ACKNOWLEDGMENTS

This work was partially supported by NSF Dissertation Improvement Grant # SES-0522630 and NSF EAGER grant # IIS-1143712.

7. REFERENCES

[1] Barsalou, L. W., Breazeal, C., and L. B. Smith (2007). Cognition as coordinated non-cognition. *Cognitive Processing*. 8(2): 79–91.

[2] Bartneck, C., Nomura, T., Kanda, T., Suzuki, T. and K. Kensuke (2005). Cultural differences in attitudes towards robots. *Proc. of AISB 2005*: 1-4.

[3] Beer, R. D. (2003). The dynamics of active categorical perception in an evolved model agent. *Adaptive Behavior* 11(4): 209-243.

[4] Bennett, C.C. and K. Hauser (2013). Artificial intelligence framework for simulating clinical decision-making: a Markov decision process approach. *Artificial Intelligence in Medicine* 57(1): 9–19.

[5] Bennett C.C. and S. Šabanović. (2013). Perceptions of Affective Expression in a Minimalist Robotic Face. *Proc. of HRI'13*. pp.81-82.

[6] Bennett, C.C. and S. Šabanović (2014). Deriving minimal features for human-like facial expressions in robotic faces. *International Journal of Social Robotics*. In Press.

[7] Bennett C.C. and S. Šabanović (2014). The effects of culture and context on perceptions of robotic facial expressions. *Interaction Studies*. In Submission.

[8] Brooks, R. A. (2002). *Flesh and Machines: How Robots Will Change Us*. New York: Pantheon Books.

[9] Brooks, R. A. (1991). Intelligence without reason. *Robotics and Autonomous Systems* 20(2-4): 291-304.

[10] Caporael L. R. (1997). The evolution of truly social cognition: The core configuration model. *Personality and Social Psychology Review* 1: 276-298.

[11] De Jaegher, H. and E. Di Paolo (2007). Participatory sense-making: An enactive approach to social cognition. *Phenomonolgy in Cognitive Science* 6: 485-507.

[12] De Jaegher, H., Di Paolo, E., and S. Gallagher (2010). Can social interaction constitute social cognition? *Trends in Cognitive Science* 14(10): 441-447.

[13] Evers, V., Maldonado, H.C., Brodecki, T.L. and Hinds, P.J. 2008. Relational vs. group self-construal: Untangling the role of national culture in HRI. *Proc.of HRI'08*: 255-262.

[14] Fischer, M. J. (2007). Culture and cultural analysis as experimental systems. *Cultural Anthropology 22(1)*: 1-65.

[15] Froese, T. and E. A. Di Paolo (2011). The enactive approach: Theoretical sketches from cell to society. *Pragmatics & Cognition* 19(1): 1-36.

[16] Fujimura, J.H. (2005). Postgenomic futures: Translations across the machine-nature border in systems biology. *New Genetics and Society 24*(2): 195-226.

[17] Gates, B. (2007). A robot in every home. *Scientific American 296(1)*: 58–65

[18] Geraci, R. M. (2006). Spiritual robots: Religion and our scientific view of the natural world. *Theology and Science 4*(3): 229-246.

[19] Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston, MA, USA: Houghlin Mifflin.

[20] Hall, E. T. (1976). *Beyond Culture*. Anchor Books.

[21] Hess, D. J. (1995). *Science and Technology in a Multicultural World.* Columbia University Press.

[22] Hoffman, G. and K. Vanunu (2013). Effects of robotic companionship on music enjoyment and agent perception. *Proc. of HRI'13*: 317-324.

[23] Hofstede, G. (1991). *Cultures and Organizations: Software of the Mind*. McGraw-Hill.

[24] Hornyak, T.N. (2007). *Loving the Machine: The Art and Science of Japanese Robots*. Kodansha International: Tokyo.

[25] Ito, K. (2007). Astroboy's birthday: Robotics and culture in contemporary Japanese society. Paper presented at *EASTS 2007*. http://stspo.ym.edu.tw/easts/2007/Ito.pdf.

[26] Kaplan, F. (2004). Who is afraid of the humanoid? Investigating cultural differences in the acceptance of robots. *International Journal of Humanoid Robotics 1*(3): 465-480.

[27] Kitano, N. (2006). „Rinri:" An incitement towards the existence of robots in Japanese society. *Ethics in Robotics 6*: 78.

[28] Kober, J.J., Bagnell, A. and J. Peters (2013). Reinforcement learning in robotics: A survey. *International Journal of Robotics Research* 32(11): 1238-1274.

[29] Lee, H.R. and S. Šabanović (2013). Weiser's dream in the Korean home: Collaborative study of domestic roles, relationships, and ideal technologies. *Proc. of UbiComp 2013*: 637-646.

[30] Lee, H.R., Sung, J., Šabanović, S., and J. Han (2012). Cultural design of domestic robots: A study of user expectations in Korea and the United States. *Proc. of RO-MAN 2012:* 803-808.

[31] Lin, W., Rau, P.L.P., Evers, V., Robinson, B.K., and P. Hinds (2010). When in Rome: The role of culture & context in adherence to robot recommendations. *Proc. of HRI'10:* 359-366.

[32] Lindblom, J. and T. Ziemke (2003). Social situatedness of natural and artificial intelligence: Vygotsky and beyond. *Adaptive Behavior* 11(2): 79-96.

[33] Macdorman, K., Vasudevan, S., and C. C. Ho (2009). Does Japan really have robot mania? Comparing attitudes by implicit and explicit measures. *AI & Society 23* (4): 485-510.

[34] Macinnes, I. and E. Di Paolo (2006). The advantages of evolving perceptual cues. *Adaptive Behavior* 14(2): 147-156.

[35] Merleau-Ponty, M. (1945). *Phénoménologie de la Perception*. Paris, France: Gallimard.

[36] Michalowski, M.P., Šabanović, S. and H. Kozima (2007). A dancing robot for rhythmic social interaction. *Proc. of HRI'07*: 89-96.

[37] Morley, D. and K. Robins (1995). Techno-orientalism: Japan panic. In Morley. D (Ed.) *Space of Identity: Global Media, Electronic Landscapes, and Cultural Boundaries*. London: Routledge, pp. 147-173.

[38] Nye, D.E. (2007). *Technology Matters: Questions to Live With.* Cambridge MA: The MIT Press.

[39] Rehm, M. (2013). From multicultural agents to culture-aware robots. In Kurosu M. (Ed.), *Human-Computer Interaction: Human-Centered Design Approaches, Methods, Tools, and Environments (LNCS).* Springer, pp. 431-440.

[40] Rehm, M., Bee, N., Endrass, B., Wissner, M., Andre, E., (2007). Too close for comfort? Adapting to the user's cultural background. *Proc. of HCM'07*: 85-94.

[41] Robertson, J. (2007). Robo sapiens Japanicus: Humanoid robots and the posthuman family. *Critical Asian Studies* 39(3): 369-398.

[42] Šabanović, S. (2014). Inventing Japan's "robotics culture:" The repeated assembly of science, technology, and culture in social robotics. *Social Studies of Science*. http://sss.sagepub.com/content/early/2014/01/17/0306312713509704.abstract

[43] Šabanović, S. (2010). Robots in society, society in robots--Mutual shaping of society and technology as a framework for social robot design.' *International Journal of Social Robotics* 2(4): 439-450.

[44] Šabanović, S. (2010). Emotion in robot cultures: Cultural models of affect in social robot design. *Presented at Design and Emotion 2010*, 4-7 October 2010, Chicago IL, USA.

[45] Šabanović, S., Michalowski, M.P. and R. Simmons (2006). Robots in the wild: Observing human-robot social interaction outside the lab. *Proc. of AMC'06*: 596-601.

[46] Schodt, F.L. (1988). *Inside the Robot Kingdom: Japan, Mechatronics, and the Coming Robotopia.* New York: Kodansha International.

[47] Shaw-Garlock, G. (2009). Looking forward to sociable robots. *International Journal of Social Robotics 1*(3): 249-260.

[48] Shibata, T., Wada, K., Ikeda, Y., and S. Šabanović (2009). Cross-cultural studies on subjective evaluation of a seal robot. *Advanced Robotics 23* (4): 443-458.

[49] Shore, B. (1996). *Culture in Mind: Cognition, Culture, and the Problem of Meaning.* Oxford: Oxford University Press.

[50] Suchman, L. (2007). *Human-Machine Reconfigurations: Plans and Situated Actions.* Cambridge University Press.

[51] Turkle, S. (2011) *Alone Together: Why We Expect More from Technology and Less From Each Other.* New York: Basic Books.

[52] von Uexküll, J. (1934). A stroll through the worlds of animals and men: A picture book of invisible worlds. In C. Schiller (Ed.), *Instinctive Behavior: The Development of a Modern Concept*. New York: International Universities Press.