Human Factors in Robots, Drones and Unmanned Systems, Vol. 218, 2026, 59–65
https://doi.org/10.54941/ahfe1007678

Emotive Design Heuristics: A Methodology for Creating and Validating Empathetic Design Heuristics for Human-Robot Interaction

Andre W. Kushniruk, Seper Rohani, and Elizabeth M. Borycki

School of Health Information Science, University of Victoria, Victoria, Canada

ABSTRACT

Design of emotional interaction between AI-based technologies and humans will be key to their successful deployment and implementation in a wide range of domains and real-world applications. Empathetic design focuses on the development of systems and technologies to which humans can connect and empathize with. In this research we have generated a novel methodology for developing evidence-based, empathetic design heuristics that can be applied by designers and evaluators of human-robot interaction and conversational AI agents in order to guide in their design and evaluation. The objective is to maximize effective and positive emotive response by humans in their interaction with robots and related AI technologies. The methodology described involves a number of steps, beginning with consideration of the evidence-based published literature on human-robot empathetic design. This was followed by an expert panel extracting a set of design heuristics from the reviewed literature, with several rounds of heuristic development and subsequent validation of the resultant emotive design heuristics by an expert panel. Implications for the design and evaluation of social robots in healthcare are discussed.

Keywords: Emotive design, Empathetic design, Robotics, Human-robot interaction, Human factors, Design guidelines, Heuristics

INTRODUCTION

The introduction of robots in domains such as healthcare promises to help streamline and modernize healthcare, as advances in social robots rapidly transform work. In healthcare robots have the potential to free up resources, increase efficiencies and support healthcare workers. However, a number of human factors related issues need to be further explored in order to achieve the potential of robotics and AI in healthcare (Schneiderman, 2022). One area of considerable interest is in the development of robots capable of displaying empathetic user interaction, which will require advances in empathetic design (Norman, 2007; Walter & Spool, 2011). Empathetic design focuses on developing systems and technologies to which humans can connect and empathize with (Preece, Rogers, & Sharp, 2015). No where is the more important than in developing robotic applications for use by healthcare providers and patients in the complex and human-centred domain

Received February 6, 2026; Revised March 30, 2026; Accepted April 15, 2026; Available online July 20, 2026

of healthcare (Kushniruk, Kaufman, Kannampallil, & Patel, 2024). In this paper we describe a methodology for creating a set of design heuristics that can be used to by both designers and evaluators of robotic applications. The heuristics are developed for supporting designers by providing a list of features and functions that have been found to be associated with empathetic design in social robotics. The heuristics can also form a dual purpose of being used for assessing the degree of empathy displayed by robots in use or in design, for both formative and summative evaluation purposes.

In the authors' prior work in the area of designing evidence-based heuristics for the safe design and assessment of advanced electronic health record software, it was found that a useful set of heuristics could be developed through a process that involved an initial a systematic review of relevant published literature on the safety of these systems (Borycki, Kushniruk, & Carvalho, 2013). This was followed by development of a set of design heuristics which were based on results of the initial literature review (Carvalho, Borycki, & Kushniruk, 2009). The method was initially designed to create a set of safety heuristics that could be used in clinical simulations to identify and prevent possible technology-induced errors related to using health information systems (Borycki, Kushniruk, & Carvalho, 2013). In related work we also employed the method to create a set of heuristics for use in designing and evaluating pervasive computing applications in healthcare (Kushniruk & Borycki, 2007). In this paper we describe how we have extended and generalized our initial approach for a new application in designing emotive user interfaces as well as development of evidence-based empathetic design heuristics to support development and evaluation of empathetic human-robot interaction and AI-based interactions with humans.

METHODOLOGICAL APPROACH

The method we have proposed and used for supporting empathetic human-robot interaction involves the following sequential phases:

Phase 1: The published literature on emotive aspects of design in the development of robots for healthcare is first reviewed using a scoping review methodology (Arksey & O'Malley, 2005). This could, for example, involve using the IEEE Xplore database and searching it by applying relevant keywords, such as "emotive design", "empathetic design" and "robots" to guide the search.

Phase 2: A set of empathetic design heuristics can then be derived from the review of the results from phase 1 (i.e. reviewing the main findings from articles in the scoping review) – these heuristics highlight specific features and functions of robotic design associated with effective and satisfying levels of emotional response. The heuristics correspond to and encapsulate key findings from the reviewed papers that indicate how specific aspects of empathetic design can be supported. This involves identification and extraction of key insights (from the articles reviewed) found to be associated with high levels of human-robot empathetic interaction. For example, from the literature it has been found that the ability of a robot to adjust to different cognitive

levels of humans is a design feature associated with increased empathetic engagement. From one of our initial projects applying this method, our extraction of heuristics from the review findings (from Phase 1) resulted in an initial set of 78 heuristics, each heuristic being associated with a specific design feature or function found to support satisfying human emotional response in interaction with robots.

Phase 3: The heuristics from phase 2 are then validated with input from experts in human-technology interaction and empathetic design. This involves presenting the initial set of heuristics to a panel of design experts in a round table format. The experts then rank and group the heuristics in terms of themes and importance for supporting effective emotive user interaction. With the removal of duplicate heuristics, a final set of heuristics emerges.

RESULTS AND EXPERIENCES TO DATE WITH THE METHODOLOGY

We are currently working on a number of projects employing the method described in this paper. This includes our prior work on application for evaluating advanced electronic health record systems to our current work in applying the approach in the design and evaluation of human-robot interaction, as will be described below.

Empathetic and Emotive User Interfaces

Our initial work in developing empathetic design heuristics involved general design heuristics that could be applied in development of user interfaces targeted to marginalized and vulnerable populations (to elicit personal information from them prior to physician visits) (Borycki, Kletke, Whitehouse, & Kushniruk, 2024; Borycki, Kletke, Nobel, McWilliams, Whitehouse, & Kushniruk, 2024). For example, Borycki et al. (2024) describe several specific heuristics that were developed under the super-category of "Personalization Heuristics", such as the following: (1) Personalization improves perceived empathy; (2) Caring computer-based messages improve perceive empathy; (3) Personalized messages increase user engagement and empathy; (4) Personalized information increases empathy. Other heuristic super-categories included heuristics grouped under the following categories: Engagement, Reward, Use of Imagery, Content and Usability, Access and Quality. After review of the full set of heuristics by an expert panel a total of approximately 50 heuristics were identified, organized in 14 super-categories.

For evaluating and validating the heuristics, several human factors experts observed and rated users' interactions with several user interface products under study, identifying the presence of features and functions identified from the list of heuristics. A comparison was then made of the different products which were evaluated for the presence of heuristic design features that have been shown in the literature to support emotive interaction (with the subjective user ratings of empathy obtained from empathy scales). In one study we compared four different online questionnaire platforms for the presence or absence of emotive design features and the heuristics. From that work we were able to clearly identify the platform that had the most

emotive and empathetic user interface (Kushniruk, Farghali, Holizki, Kletke, Le Nobel, McWilliams, Wagner, Zinovich, Whitehouse, & Borycki, 2024). The approach described in this paper has also been used to both evaluate the level of emotive interaction, validate the heuristics, as well as to provide feedback about potential addition of features and functions that would promote higher levels of satisfying emotive interaction.

To date, we have also tested the effectiveness of these evidence-based heuristics we have developed by conducting human-in-the-loop simulations and usability evaluations, with the objective of assessing the extent to which the heuristics can be used to evaluate emotive user interaction with AI technologies.

Empathetic and Emotive Human-Robot Interaction

Our current work includes creating heuristics for design and evaluation of human interaction with social robots being used in healthcare and other domains (e.g. the Pepper® and Nao® robots). The method we have applied first involved conducing a scoping review of empathy in human-robot interaction, searching the PubMed and IEEE Xplore databases to identify articles in the past ten years using the selected keywords: "empathy" and "robot" and "healthcare" (Kushniruk, Rohani, & Borycki, in press). Using this method, 127 articles were retrieved from PubMed and 25 from IEEE Xplore. After initial screening 51 articles were selected for full-text detailed review. Themes and individual findings from these articles related to increasing emotive human-robot interaction were identified, with two main mechanisms identified: feature and functions associated with the ability of robots to stimulate empathy, and features and functions associated with the ability of robots to elicit empathy from humans. Heuristics associated with increased emotive reaction were then identified. The following categories related to design of human-robot interaction have been identified through this process: (1) self-disclosure and personalization (2) pleasing aesthetics (3) features eliciting trust (4) comfort during the interaction (5) level of user engagement (6) level of physical interaction and (6) presence of socialization capabilities. Our future objective is to apply the resultant empathetic design heuristics to evaluate a range of commercial robots being introduced in healthcare settings (including hospitals, elder care homes and assistive living contexts). Our first level of application has involved observing the robots in action and using the heuristics as a check list to identify which emotive design features and functions were present in observing a test interaction with human subjects.

DISCUSSION

There is great potential for social robots to transform, streamline and optimize complex work domains. This potential is especially relevant given the limited resources and labour shortages in areas involving intensive human interaction, such as healthcare, where social robots could help alleviate some of these ongoing issues. However, in order to develop advanced AI and robotic

applications that truly interact with humans in natural and effective ways, greater consideration needs to be given to emotive and empathetic design of these technologies. From our previous work we have found that there is a great amount of evidence available from the published literature that gives clues as to what leads to robotic design that is emotive and satisfying from the perspective of the human user who interacts with the technology. Evidence-based heuristics are those heuristics that can be developed from critical examination of the existent literature on human-robot interaction.

Our previous work in developing evidence-based heuristics has involved application in areas such as safety of health information systems and in developing applications (e.g. on-line questionnaires for asking patients about sensitive health information) that elicit emotive response, leading to higher and more honest responses from those interacting with them. Our latest work in developing and applying evidence-based heuristics is extending the approach to identifying generic features and functions from the published literatures that are associated with increased emotive response. We are also working on validating the sets of heuristics we have created to date and will be exploring the further application and validation of the heuristics in a wider range of applications, including a number of AI applications such as large language models (LLMs). We will also be exploring their use in analysing and evaluating a range of healthcare robots, in particular therapeutic robots, which are increasing being used in areas such as dementia care and used in setting such as assistive living environments (Góngora Alonzo, Hamrioui, de la Torre Díez, Motta, López-Coronado, & Franco, 2019). In terms of application of our work, the resultant emotive design heuristics can be used for multiple purposes. This includes using the heuristics for rating the level of positive emotive interaction for robotic application in areas such as elder care, which can be used for input into refinement of emerging human-robot interactions, as well as for providing input into comparing and selecting (e.g. procuring robots for use in healthcare) from among different commercially available robots. In addition, the heuristics could be used by designers of robots, as design principles to guide in the development of effective emotive human-robot interactions.

Many researchers have applied generic sets of heuristics to assess the usability of information systems for usability evaluations since the early 1990s (Gonzalez-Holland, Whitmer, Moralez, & Mouloua, 2017; Nielsen, 1994). However, development of heuristics that are specialized to a domain such as healthcare has also proven to be extremely useful for assessing both system usability and safety (although limited to a specific work domain). In our previous work we have described a method for developing such specific sets of heuristics for use in areas such as supporting and evaluating design of pervasive applications in healthcare (Kushniruk & Borycki, 2007). In our current work we have extended this approach to the development of evidence-based heuristics that can be used for assessing the emotive interaction of humans with robots. The heuristics are specific to this purpose and they can be applied using the heuristic evaluation approach, whereby a robotic or AI-based application is rated in relation to how well it conforms to or embodies the principles contained in the heuristics. However, this approach

has considerable potential for extension of the heuristics to the design and evaluation of robots in other complex domains and for use in the design and evaluation of a range of emerging AI applications involving close interaction with humans.

CONCLUSION

Research on emotive design will be critical to inform the design of robotic and AI applications by identifying key features and functions that will likely lead to effective emotive interaction with humans. As such, heuristics can be used to guide both designers and evaluators. In this paper we have described a methodological approach we have developed for creating, validating and applying evidence-based empathetic design heuristics. The development of such a set of evidence-based design heuristics can help support an innovative approach to designing and evaluating human-robot interaction and can be applied in areas like healthcare and other complex domains, using heuristics focused on aspects such as emotive/empathetic design, safe design and pervasive design.

ACKNOWLEDGMENT

The authors would like to acknowledge that Dr. Elizabeth Borycki is supported by a Health Research BC Health Professional Investigator Award. This research was partially supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) RGPIN202006950.

REFERENCES

Arksey, Hilary, and Lisa O'Malley. "Scoping studies: towards a methodological framework." *International journal of social research methodology* 8.1 (2005): 19–32.

Borycki, E. M., Kletke, R., Le Nobel, C., McWilliams, G., Whitehouse, S., & Kushniruk, A. W. (2024). Empathetic and emotive design heuristics. In *pHealth 2024* (pp. 80–84). IOS Press.

Borycki, E. M., Kletke, R., Whitehouse, S., & Kushniruk, A. W. (2024). Empathetic and emotive design: a scoping review. *pHealth 2024*, 85–89.

Borycki, E., Kushniruk, A., & Carvalho, C. (2013). A Methodology for Validating Safety Heuristics Using Clinical Simulations: Identifying and Preventing Possible Technology-Induced Errors Related to Using Health Information Systems. *Computational and mathematical methods in medicine*, *2013*(1), 526419.

Carvalho, C. J., Borycki, E. M., & Kushniruk, A. W. (2009). Ensuring the safety of health information systems: Using heuristics for patient safety. Healthcare Quarterly, Volume 12, pp. 49–54.

Góngora Alonso, S., Hamrioui, S., de la Torre Díez, I., Motta Cruz, E., López-Coronado, M., & Franco, M. (2019). Social robots for people with aging and dementia: a systematic review of literature. *Telemedicine and e-Health*, *25*(7), 533–540.

Gonzalez-Holland, E., Whitmer, D., Moralez, L., & Mouloua, M. (2017, September). Examination of the use of Nielsen's 10 usability heuristics & outlooks for the future. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 61, No. 1, pp. 1472–1475). Sage CA: Los Angeles, CA: SAGE Publications.

Kushniruk, A, Borycki, E. M. (2007). Human factors and the usability of healthcare systems. In Bardram, J. E., Mihailidis, A., & Wan, D. (Eds.) *Pervasive computing in healthcare*. CRC Press, Inc.

Kushniruk, A. W., Farghali, A., Holizki, L., Kletke, R., Le Nobel, C., McWilliams, G., Wagner, G., Zinovich, S., Whitehouse, S. & Borycki, E. M. (2024). Empathetic and emotive design heuristics: preliminary results of their application to evaluating survey user interfaces. In *pHealth 2024* (pp. 75–79). IOS Press.

Kushniruk, A. W., Kaufman, D. R., Kannampallil, T. G., & Patel, V. L. (2024). *Human Computer Interaction in Healthcare: The Role of Cognition*. Springer.

Kushniruk, A. W., Rohani, S., & Borycki, E.M. (in press). IOS Press.

Nielsen, J. (1994). *Usability engineering*. Morgan Kaufmann.

Norman, D. (2007). *Emotional design: Why we love (or hate) everyday things*. Basic books.

Preece, J., Rogers, Y., & Sharp (2015). Interaction design (4th edition). Chichester, West Sussex: John Wiley and Sons.

Shneiderman, B. (2022). *Human-centered AI*. Oxford University Press.

Walter, A., & Spool, J. M. (2011). *Designing for emotion*. New York: A book apart.