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The Influence of Culture on Attitudes Towards Humanoid and Animal-like Robots: An Integrative Review

Irena Papadopoulos, PhD, RCM, RGN, FHEA[1], & Christina Koulouglioti, PhD, RN[2]

1 Professor of Transcultural Health and Nursing, School of Health & Education, Hendon Campus, Middlesex University, London, UK
2 Senior Research Fellow, Research Centre for Transcultural Studies in Health, Middlesex University, London, UK, and Research and Innovation Department, Western Sussex Hospitals NHS Foundation Trust, Worthing, UK

Key words
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Correspondence
Prof. Irena Papadopoulos, School of Health & Education, Hendon Campus, Middlesex University, The Burroughs, London NW4 4BT, UK. E-mail: R.Papadopoulos@mdx.ac.uk

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Abstract

Purpose: The aim of the present review is to explore the influence of culture on attitudes towards humanoid and animal-like robots.
Design: An integrative review of current evidence.
Methods: Medline, CINAHL, PsycInfo, PubMed, and Google Scholar were searched from 2000 to 2017. A total of 22 articles met the inclusion criteria and were retrieved and analyzed.
Findings: Culture influences attitudes and preferences towards robots, but due to the limitations of the reviewed studies, concrete conclusions cannot be made. More consistent evidence was found with regard to the influence of culture on nonverbal behaviors and communication styles, with people being more accepting of a robot that behaved more closely to their own culture.
Conclusions: The research field of human–robot interaction provides the current evidence on the influence that culture has on attitudes towards humanoid and animal-like robots, but more research that is guided by strong theoretical frameworks is needed.
Clinical Relevance: With the increased use of humanoid robots in the healthcare system, it is imperative that nurses and other healthcare professionals explore and understand the different factors that can affect the use of robots with patients.

The use of robotic technology is slowly increasing in health care, moving beyond the use of robotics in operating rooms, rehabilitation, and telemedicine. The adoption of new technology can be challenging, and it is influenced by many factors. The Diffusion of Innovation Theory clearly states that the compatibility of an innovation with sociocultural values and perceived needs is one critical characteristic that can accelerate or hinder the adoption of a new technology (Kaminski, 2011). Knowing that culture influences a person's health beliefs and decisions, the present review focuses on exploring how culture impacts attitudes towards assistive robots and in particular humanoid and animal-like robots.

The use of robots in health care is especially relevant to nurses, since humanoid and animal-like robots are being used as therapeutic tools such as the use of the pet seal PARO in dementia care (Birks, Bodak, Barlas, Harwood, & Pether, 2016; PARO Therapeutic Robot, 2014). PARO has been found to improve the mood of dementia patients and to decrease isolation (Robinson, Broadbent, & MacDonald, 2016), whereas other robots have been used to provide support among older adults and assist with mobility, self-care, and interpersonal interaction (Bedaf, Gelderblom, & de Witte, 2015).

Robots are considered a promising technology that can assist and prolong independent living among older adults (Khosravi & Ghapanchi, 2016), and with the world's population rapidly aging, the number of older adults requiring long-term care is also increasing, as is the number of those who live longer with disabilities, like visual impairment and other chronic problems (World Health Organization, 2012).

A few individual factors have been found to influence the acceptance of robots among older adults. A person's age, gender, level of education, and previous experience with technology, but also a person's perceived need for the technology and culture, seem to impact his or her acceptance (Broadbent, Stafford, & MacDonald, 2009). However, we do not know what other behaviors, beyond acceptance, culture might influence or how and in what way culture impacts the relationship and interaction between a human and a robot.

The influence of culture on health, which has been well documented in the literature, should not be underestimated. Starting in the 1950s, by demonstrating the influence of culture on the expressions of pain (Zaborowski, 1952) to a recent review showing that culture influences even nonverbal expressions of empathy during patient–clinician encounters and significantly impacts the quality of communication and care (Lorié, Reinero, Phillips, Zhang, & Riess, 2017), culture is now an important variable in healthcare research and development. We define culture as the shared way of life of a group of people that includes beliefs, values, ideas, language, communication, norms, and visibly expressed forms such as customs, art, music, clothing, food, and etiquette (Papadopoulos, 2006).

Hofstede, Hofstede, and Minkov (2010), after an extensive study of workplace values and culture, identified six main dimensions of national culture that distinguish countries (rather than individuals) from each other on certain independent preferences. These six dimensions are (a) individualism, (b) power distance, (c) masculinity, (d) uncertainty avoidance, (e) long-term orientation, and (f) indulgence. Notwithstanding the usefulness of the national indices produced by Hofstede's cultural dimensions, and the consensus on certain universal values as expressed in human rights codes and legislation, Papadopoulos (2006) has argued that at a cultural or ethnic group level as well as at the individual level, cultural differences exist in terms of values, perceptions, and attitudes; their manifestation in decisions taken about self-care practices; the status designated to rituals, routines, and relationships; and the reactions to and management of life course events and challenges.

Nurses strive for offering culturally competent care by recognizing the existence of cultural differences and by effectively communicating, intervening, and creating a working environment that considers social and cultural influences. Living in a multicultural society dictates the need to provide culturally competent care, and existing evidence has shown that culturally competent professionals have a positive impact on patient satisfaction (Beach et al., 2005).The introduction of robots in health care has generated an ethical debate regarding their use (Vandemeulebroucke, Dierckx de Casterle, & Gastmans, 2018), but challenging questions about the cultural competence of humanoid robots have been raised in the mass and social media outlets, such as: How can the concept of cultural competence be conceptualized for humanoid robots? Can a robot be expected to recognize cultural cues? And, if yes, will a robot be able to recognize and appropriately respond to the cultural background of the various members of the healthcare team and those of the patients?

It is highly desirable that, since culture influences human-to-human interaction, the cultural influences of human-to-robot interactions are seriously considered in order to gain the understanding needed for an effective and appropriate robotic-to-human interface. Therefore, the aim of the present review is to summarize current evidence on the influence of culture on attitudes towards humanoid and animal-like robots.

Methodology

This article reviews research studies that explored the influence of culture on attitudes towards humanoid and animal-like robots using an integrative approach. We followed Cooper's (1982) methodology for integrative reviews, which involves five stages: (a) formulating the research problem, (b) searching the literature, (c) evaluating the available evidence, (d) analyzing the data, and (e) interpreting the results.

Research Problem

The use of and demand for assistive robotic technology are increasing, and examples of its use have also been emerging in healthcare settings in the past few years. We know that culture influences a person's health beliefs and decisions, so the present review aims to investigate the influence of culture on attitudes towards humanoid and animal-like robots, and inform future work on the use of such robots in health care.

Research question: How does a person's cultural background influence his or her attitudes towards the use of humanoid and animal-like robots?

Literature Search

Three major databases—Medline, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and PsycInfo—were searched for studies published during the years 2000 to 2017, using the following predefined key words: culture or cultural characteristics or cultur* or country; robot or humanoid robots or

Table 1. Inclusion and Exclusion Criteria

Inclusion	Exclusion
1. The paper must have a focus on culture and present data	1. Position papers or theoretical papers related to culture and robotics
2. It should focus on a humanoid robot or animal-like robot	2. Articles related to other robotic technology e.g. software, surgery, equipment etc
3. Research articles in peer -reviewed journals utilising different methodologies	3. Grey literature
4. Published after 2000	4. Articles not published in English

animal robots; and accept* or acceptance or views or attitudes. Using the Boolean operator ″or″ within each family of words and the expansion tool _* after the main key words ensured that all variations of words were considered during the search. We then used the Boolean operator ″and″ to combine the main key words and identify articles that included all main key words. A total of 163 articles were identified. At this stage the key word ″healthcare″ was used as a limiting search term to identify only those articles related to healthcare contexts, but this step was futile. We therefore decided to screen all 163 articles for their relevance to the review topic. In addition, we searched using the same criteria in PubMed and Google Scholar under the direction of an expert in human–robot interaction who indicated that not all robotic journals are indexed in the three selected databases (Medline, CINAHL, and PsycInfo). Another 25 articles were retrieved and added to the pool of potential articles (total 188 articles).

We included articles written in English only, that used quantitative, qualitative, or mixed methods, and that were published in peer-reviewed journals. We excluded opinion, theoretical, or position papers, and papers that considered robotic surgery, robotic equipment (e.g., wheelchairs, bathtubs, and exoskeletons), or telemedicine, since our focus was on humanoid and animal robots used by people in different settings. Furthermore, we included only those papers that explored culture as a variable and presented actual data, for example, differences or similarities between cultural groups or attitudes of one group. We used a broad definition for culture and therefore we also included ″country″ as a key word, and we included all age groups. A summary of the inclusion and exclusion criteria can be seen in Table 1.

Study selection was then conducted using a three-stage process: title, abstract, and full text. At each stage, articles that did not meet the inclusion criteria were excluded. When it was unclear whether an article met the inclusion and exclusion criteria, the authors decided collectively after discussing each article. Further details on the search process and identification of articles are presented in the PRISMA flowchart (Figure 1). A total of 22 articles were finally included in the review. All other literature was retained as background information.

Data Extraction, Analysis of Data, and Synthesis

A summary table was first created including information for all the articles about the purpose of the study, methodology, sample size and sampling strategy, countries involved, and major findings. Additional notes were kept for each article related to data collection, type of experiment, the use of theory, and quality criteria. Data extraction and generation of major themes followed a four-stage process. The first stage comprised immersion into the data by reading each article multiple times and focusing on the concept of culture. This included how culture was defined and measured, which countries were included, and what was the focus of the study and methodology. At the second stage, special attention was given to the findings of each study, and initial codes were generated. These codes were reviewed for the identification and verification of recurrent themes. These were reviewed and discussed by both authors. Once the themes were agreed upon, the relevant data were synthesized and discussed under three major themes, and the authors raised and posed new questions. In addition, the summary table was revised to include only specific information for each article and findings related to culture (Table 2).

Evaluating Quality

The Critical Appraisal Guide for Quantitative Studies (Fineout-Overholt, Melnyk, Stillwell, & Williamson, 2010) was used to assess the quality of the studies described in the included articles, since, with the exception of one study that used mixed methods, all others utilized quantitative methodology. All studies had a well-defined research question; however, the major limitation identified was in relation to sample size and sample selection. As seen in Table 2, almost half of the reviewed studies included very small sample sizes, and the subgroup analysis was done in groups that

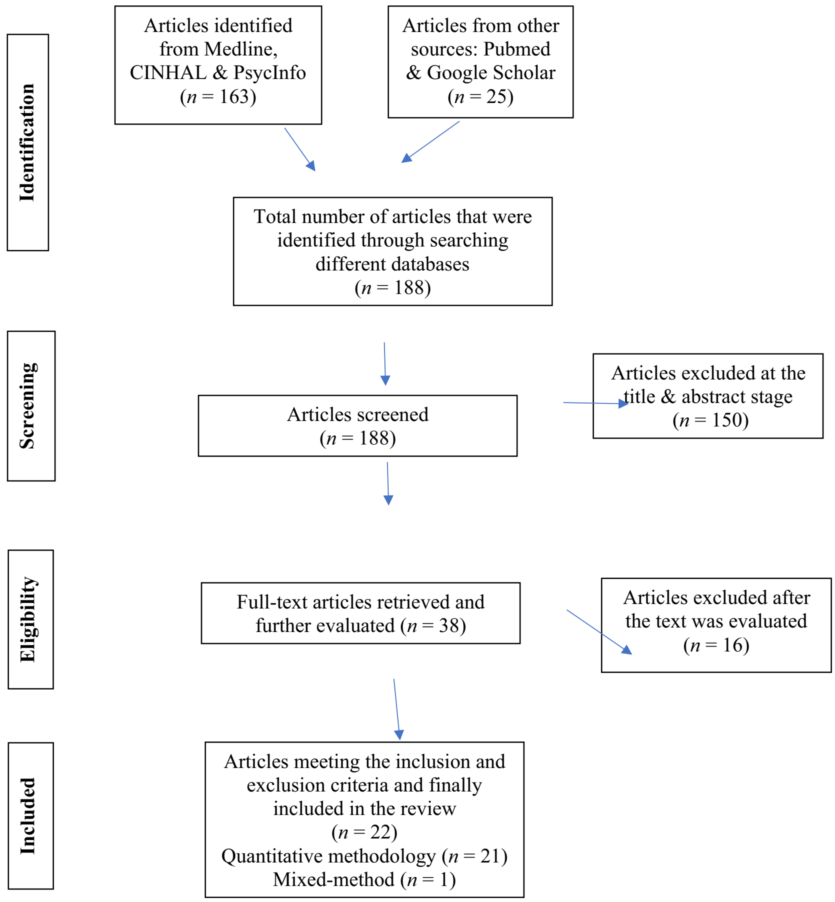

Figure 1. PRISMA flow chart. [Colour figure can be viewed at wileyonlinelibrary.com]

had less than 30 participants. As a result, findings, potential differences or the lack of identified differences, and possible implications had to be addressed with caution. Furthermore, most of the studies included only university students or participants who were recruited by social network websites and completed the study online. All studies used a convenience sampling strategy, and most of the articles did not report their recruitment strategy. These factors pose additional threats to external validity by limiting any possible generalizability of the results to young adults and those with access to computers and the Internet. Researchers did not always use validated questionnaires for data collection, raising concerns about the internal validity of the studies, but a few examples of validated measures were existent, such as the Negative Attitudes Towards Robots Scale (Bartneck, Nomura, Kanda, Suzuki, & Kennsuke, 2005; Nomura, Syrdal, & Dautenhahn, 2015); the Frankenstein Syndrome Questionnaire (Nomura et al., 2015); and the Godspeed Questionnaire (Haring, Silvera-Tawil, Matsumoto, Velonaki, & Watanabe, 2014). The experimental conditions were usually well thought out, and participants were randomly assigned to simulated robotic scenarios or tasks, which is a positive aspect. Culture was defined on the country level, and this is how cross-cultural comparisons were made. The underpinning theoretical framework of most studies was not present to guide the development of tested hypotheses, and the studies that included a theory referenced mainly Hall's framework (Hall, 1990), Hofstede's dimensions (Hofstede et al., 2010), and the Uncanny Valley Hypothesis (Destephe et al., 2015).

Results

Three major themes capture the current evidence on the influence of people's cultural background on attitudes towards humanoid and animal-like robots. Those themes follow.

Cultural Attitudes and Behaviors Towards Robots

Culture was found to influence attitudes but also many other behaviors towards robots. Beyond attitudes,

Table 2. Summary of reviewed articles

	Authors Year	Aim	Methodology and sampling	Countries	Findings related to cultural influence
1	Bartneck et al., (2005)	To explore cross-cultural differences in attitudes towards robots.	Cross-sectional, descriptive, administration of a questionnaire completed by N = 96 adults, mostly university students (n = 24 Dutch, n = 19 Chinese, n = 53 Japanese). Convenient sample	Netherlands, China, Japan	Dutch and Chinese were less concerned on the social influence of robots compare to the Japanese
2	Bartneck et al., (2007)	The influence of culture and previous experience with robots on attitudes towards robots	Online survey of N = 467 participants from 7 countries. A convenient sample recruited from universities and online communities of people owning a robot	China, Japan, Germany, Netherlands, UK, USA & Mexico	Mexican the most negative towards robots, US the more positive, especially when asked about interacting with robots. Japanese were more concerned about the social influence of robots, especially emotional aspects of interacting with robots
3	Bartneck, (2008)	The influence of cultural background on a person's perception of the robot's likeability and anthropomorphism	Online questionnaire of N = 112 participants (n = 54 USA & n = 58 Japan) affiliated with a university. Participants answered questions about photos depicting different robots. Convenient sample.	Japan, USA	USA participants liked more the human-like robots whereas Japanese reported the opposite. The more human-like the less it was liked by the Japanese
4	Nomura et al., (2008)	To investigate cross-cultural assumptions about robots.	Questionnaire completed byuniversity students from Japan (n = 313), South Korea (n = 317) and USA (n = 166). A convenient sample selected from different university departments	Japan, South Korea, USA	All students thought that humanoid robots can perform certain tasks in society. Japanese students were more likely to assume that a humanoid robot can do human tasks than the USA and S. Korean counterparts. S. Korean students thought that robots are appropriate for medical tasks more strongly than the Japanese students but reported more negative attitudes towards the social influence of robots than the Japanese. US students had both more positive and more negative images of robots than the Japanese
5	Rau et al., (2009)	To investigate how people from different countries will be influenced by a robot's language and communication style	Laboratory experiment using a robot with N = 32 university students (n = 16 from each cultural background) using random assignment for the condition/task and post measures only. A convenient sample of university students excluding students from robotics and artificial intelligence departments	China, Germany	German students rated the robot lower in likeability, trust, source credibility and accepted the robot's recommendations fewer times than their Chinese counterparts. In regard to implicit communication style (when the robot communicated in an implicit way) Chinese participants were more likely to be influenced by the robot's recommendations and they trusted and preferred the robot more often than the German participants; no differences were found when the explicit communication style was used

(Continues)

Table 2. (Continued)

	Authors Year	Aim	Methodology and sampling	Countries	Findings related to cultural influence
6	Li et al., (2010)	To investigate how a person's cultural background influences their perception and evaluation of a robot	Lab experiment, N = 108 university students (n = 36 from each cultural background). Random assignment to a robot and task and questionnaires post interaction. A convenient sample	China, Korea, Germany	German participants scored low on trust, likeability, satisfaction and engagement compare to the Chinese and Korean participants. Korean scored lower in trust than the Chinese. An interaction between culture and task with engagement with Germans being more influenced in their engagement with the robot depending on the task than the Koreans and Chinese
7	Eimler et al., (2011)	To explore cultural differences on emotion attribution when interacting with a robot rabbit.	Cross- sectional, comparison between USA (n = 111) & German (n = 100) group. Convenient sample recruited through social media networks in Germany and a university in US	USA, Germany	Not significant differences between the two groups. Both German and USA participants attributed similar emotions to the robot's non-verbal communication behaviours
8	Shahid et al., (2011)	To explore whether a child's cultural background influences their interaction with an animal robot.	N = 100 (n = 48 Pakistani & n = 52 Dutch) convenient sample from elementary schools participated in a lab experiment. A random sample of videotaped interactions of children and robots were coded	Netherlands, Pakistan	Pakistani children were more expressive when interacting with iCat robot, sat closer and had longer conversations compared to Dutch children
9	Pigini et al., (2012)	To explore user's needs and perceptions about service robots in elderly care	Mixed method: focus groups (N = 59) using a purposive sample & completion of questionnaires (N = 129) by a convenient sample	Italy, Spain, Germany	Spanish participants more positive attitudes towards the usefulness of the robot compared to Italian and Germans who had more objections in the use of robots in cooking and body care
10	Eresha et al., (2013)	To investigate the effect of culture on interpersonal distance during a human-robot interaction.	Laboratory experiment using a robot with N = 24 adults (n = 12 & n = 12 from each background) and measuring distance. A convenient sample	Participants of Arab and German background	Arab participants positioned themselves in closer proximity to the robot than the Germans
11	Trovato et al., (2013)	To investigate whether cultural background influences the acceptance towards a humanoid robot.	Lab experiment with a convenient sample of N = 61 (n = 36 Egyptians, n = 25 Japanese). Participants were exposed to a simulated video conference with a robot and completed questionnaires	Egypt, Japan	Participants liked the robot that felt closer to their culture (e.g. Japanese liked more the robot that spoke and greeted them in Japanese)
12	Torta et al., (2014)	To evaluate a small humanoid assistive robot used by older adults in a home smart environment.	Laboratory experiment using a robot with a convenient sample of N = 16 adults (8 & 8 from each country). Participants completed questionnaires after interacting with the robot	Austria, Israel	No major cultural differences. A statistical significant difference was noted on perceived ease to use of the robot with the Israeli participants scoring lower than the Austrians
13	Lee & Sabanivic, (2014)	To explore perceptions and preferences regarding robots.	Online survey, Korean (n = 73), American (n = 99) & Turkish (n = 46) adults. Convenient sample	South Korea, USA, Turkey	Korean participants preferred human-like robots and thought they could be part of social life whereas USA participants preferred machine-like robots, and thought of them as tools. Turkish participants had a diversity of opinions and equally liked human-like and machine-like robots

(Continues)

Table 2. (Continued)

	Authors Year	Aim	Methodology and sampling	Countries	Findings related to cultural influence
14	Haring et al., (2014a)	To compare trust, perception and attitudes towards an android robot in Japan and Australia.	Experiment, with pre-post measures on a total of *N* =111 university students across both countries (*n* = 56 Australia, *n* = 55 Japan). Convenient sample	Japan, Australia	Australians liked and trusted the robot more than the Japanese, but in terms of safety they were more concerned than the Japanese.
15	Haring et al., (2014b)	To explore attitudes towards robots.	Survey of *N* = 41 university students from Japan. Data were compared to a similar survey done in Europe. Convenient samples	Japan, Europe	Both Japanese and European participants had similar positive attitudes towards robots. Japanese showed higher preference for human-like robots
16	Trovato et al., (2015)	To explore the importance of cultural closeness on acceptance of humanoid robots.	Lab experiment, with pre-post measures on a convenient sample of *N* = 20 Dutch participants, using simulated video interactions with a robot speaking in difference accents	Netherlands	Dutch participants were more comfortable interacting with the German accent speaking robot rather than the Japanese one
17	Nomura et al., (2015)	To explore people's acceptance of a humanoid robot.	Online Survey of a convenient sample of *N* = 200 participants (*n* = 100 & *n* = 100 from each country)	UK, Japan	Older UK participants had more negative attitudes towards robots than the Japanese
18	Destepheet al., (2015)	To investigate how individual and robot characteristics influence the perception of robots	A questionnaire completed from *N* = 69 participants (*n* = 47 French, *n* = 22 Japanese) after watching specific videos of a humanoid robot. A convenient sample recruited through social network websites not related to robots	France, Japan	French participants were more positive towards the robot and felt safer with the robot than the Japanese. Japanese preferred the robot displaying natural intensity emotions over exaggerated intensity emotions (e.g. broad gestures). No difference for the French. The stereotype that Japanese will feel more positive was not supported
19	Haring et al., (2016)	To explore whether appearance and mode of interaction influences the perception of robots	Experiment, with pre-post measures on a convenient sample of *N* = 126 university students	Australia, Japan	Japanese's participants perception of robot's intelligence and safety increased after interacting with the robot. Japanese rated higher the robot on mental capability to experience (e.g. feel pain, pleasure) and agency (ability to plan, memorize)
20	Neerincx et al., (2016)	To explore children's experiences when interacting with a robot	A convenient sample of *N* = 55 children <14 years old in diabetes camps (*n* = 34 Italian, *n* = 21 Dutch). Pre and post questionnaire after a structured interaction with the robot. Interactions were videotaped and coded	Italy, Netherlands	Italian children more open, expressive and closer (physical distance) to the robot compared to the Dutch children
21	Hudson et al., (2017)	Attitudes on the use of robots for the care of the elderly in EU countries.	Analysis of Eurobarometer data on 27 EU countries *N* = 27,801	EU countries	Participants from Greece, Portugal, Cyprus and Slovenia were the most hostile towards the use of robots whereas respondents from Eastern European countries -Lithuania, Poland, Czech Republic and Austria- were the most favourite

(Continues)

Table 2. (Continued)

	Authors Year	Aim	Methodology and sampling	Countries	Findings related to cultural influence
22	Kamide & Arai, (2017)	To investigate perceived comfortableness of positive and negative features of anthropomorphised robots in US and Japan.	A convenient sample of *N* = 360 (*n* = 180 from each country) recruited online. Participants read scenarios and viewed photos of a humanoid robot, then completed questionnaires	Japan, USA	Americans were more comfortable towards human-like robots than the Japanese. Even a small number of positive or negative anthropomorphised features influences perceived comfortableness for the Japanese whereas Americans were more open to robots even if the number of positive features was small and the number of negative large

a person's engagement, trust, likeability, or perception toward a robot was culturally bound. However, a consistent picture between countries or cultures was not found. Even among nations and societies that are classified as individualistic or collectivistic, there were differences. Spanish people were found to have more positive attitudes compared to Italians and Germans regarding the usefulness of the robot, or what the robot could and should do while helping an elderly person at home (Pigini, Facal, Blasi, & Andrich, 2012). U.K. older adults were found to have more negative attitudes than Japanese older adults (Nomura et al., 2015), and Mexican participants had more negative attitudes than U.S. participants (Bartneck, Suzuki, Kanda, and Nomura, 2007). In addition, differences were found within countries of the European Union as well, with people from Greece, Portugal, Cyprus, and Slovenia being most hostile towards the use of robots, whereas people from Eastern European countries (Lithuania, Poland, Czech Republic, and Austria) were the most open to the use of robots (Hudson, Orviska, & Hunady, 2017).

German university students scored lower on trust, likeability, satisfaction, and engagement with a robot than their Chinese and South Korean counterparts, but the engagement of Germans with the robot depended on the task that the robot performed, indicating that culture influences behaviors in multiple ways (Li, Rau, & Li, 2010). Similarly, cultural differences about attitudes emerged after asking Japanese and Australian participants to interact with a robot. The perceptions of Japanese participants regarding the robot's intelligence and safety increased after the interaction, but this was not necessarily true for Australian participants (Haring, Silvera-Tawil, Watanabe, and Velonaki, 2016), raising questions about the influence of culture. Why do people from different cultures perceive different things when interacting with the same robot in similar conditions?

Another interesting finding that raises further questions about the influence of culture was the fact that Japanese students were not always found to report positive attitudes towards robots. They were more likely to assume that a humanoid robot can do human tasks than were their U.S. and South Korean counterparts (Nomura et al., 2008), but they were found to be more negative towards robots than French students (Destephe et al., 2015) and more concerned of the social influence of robots than Chinese, Dutch, Mexican, or U.S. students (Bartneck et al., 2005; Bartneck et al., 2007). Australian participants were found to like and trust the robot more than Japanese participants (Haring, Silvera-Tawil, et al., 2014). In conclusion, people from different cultures have different attitudes towards robots, and that should be taken into account when robotic products are being considered for certain countries.

Cultural Preferences Regarding the Robot's Appearance

Culture was also found to affect preferences in relation to appearance and expressions of emotions. Japanese participants preferred more natural expressions of emotion from the robot than exacerbated expressions (e.g., theatrical broad gestures; Destephe et al., 2015). Regarding preferences on robot's appearance between Japanese and European people, mixed and inconsistent results were reported. Haring, Mougenot, Ono, and Watanabe, (2014) reported that Japanese participants showed a higher preference for humanlike robots compared to their European counterparts. However, Bartneck (2008) reported that U.S. participants liked the humanlike robots than the Japanese participants did, and Kamide and Arai (2017) similarly found that U.S. participants were more comfortable towards humanlike robots than were Japanese participants. In contrast, Lee and Sabanovi? (2014) found that South Korean participants preferred humanlike robots and thought they could be part of social life, whereas U.S. participants preferred machinelike robots, and thought of them as tools. The Turkish participants in this study had a diversity of opinions and equally liked humanlike and machinelike robots. As mentioned before, that could be a result of the way concepts were defined and measured, as well as the sample size differences, but despite the inconsistencies, the question on how and why people from different cultures express different preferences is intriguing. Why do some prefer a humanlike robot but others a machinelike one? Why can some cultures view robots as part of social life and others can only consider them as tools? The idea that the closer the robot is designed to the recipient culture the more easily it will be adopted by the people of that culture is not surprising. Cultural adaptation of products for different markets is a common phenomenon, but how this idea can be translated into a healthcare context with all its cultural complexities is a challenge that will probably occupy researchers for some time to come.

Cultural Influences on Verbal and Nonverbal Communication

Another theme was related to the closeness of the robot to the recipient's culture. A robot's features, such as language and communication style, were found to influence the perceptions of people from different cultural backgrounds. For example, Rau, Li, and Li (2009) found that Chinese participants responded more positively to the robot when the robot used an implicit form of communication, but this was not true for German participants. These differences were explained by using Hall's classification of low-context and high-context countries and how people in these countries usually like to communicate. Torta et al. (2014), even though they did not report major cultural differences between Israel and Austria, speculated that language and the ability to easily understand the robot played a role in the lower rating for the use of robots from Israeli participants who could not always understand the English-speaking robot, whereas Austrian participants had fewer problems with the German-speaking one. On a similar note, Trovato et al. (2013) found that when the robot greeted the person in his or her own language and in a culturally appropriate way (e.g., bow for Japanese), it was more accepted and liked because it felt close to the person's culture. Trovato, Ham, Hashimoto, Ishii, and Takanishi (2015), testing the same hypothesis, reported that Dutch participants felt more comfortable with a robot speaking with a German accent than one speaking with a Japanese accent.

A person's cultural background was also found to affect nonverbal behaviors during human–robot interactions, as has been observed in human–human interactions. Eresha, Häring, Endrass, André, and Obaid (2013) measured the physical distance that human participants kept when interacting with a humanoid robot and found cultural differences, with Arab participants positioning themselves closer to the robot than their German counterparts. Similarly, in the two studies that involved children, it was found that Dutch children positioned themselves farther away from the robot compared to Pakistani and Italian children, who were more expressive and sat closer to the robot (Neerincx et al., 2016; Shahid, Krahmer, Swerts, & Mubin, 2011). Eimler, Krämer, and von der Pütten (2011) compared the attribution of emotions to a robot's nonverbal behavior and found that both German and U.S. participants were very similar in their attributions. It was speculated that the observed similarities could be due to the similarities of the United States and Germany under Hofstede's framework. The fact that cultural dissimilarities and similarities emerged even for nonverbal behaviors of people when interacting with robots can be helpful when planning the use of robots with a certain population. Researchers can draw from existing cultural knowledge and anticipate behaviors based on a person's culture. However, since we know that the most powerful and influential elements of culture, such as values, beliefs, expectations, and norms, are deep seated within a person, how these will be addressed by scientists so that a humanoid robot can both understand and respond to them is a major question.

Discussion

The present review aimed to summarize and analyze the existing literature regarding the influence that cultural backgrounds can have towards the use of humanoid and animal-like robots. The use of robotic technology is not a new occurrence in the healthcare system, and as robotic technology advances, so does its application. The pet seal PARO has been tested in many instances among dementia patients, especially in Australia, and now Pepper (a child-size humanoid robot) will be assisting dementia patients for the first time in the United Kingdom (Pattinson, 2017). An interesting finding was the fact that our initial search on culture, attitudes, and robots did not turn up any articles specific to the healthcare context; therefore, the review focused on articles retrieved from other disciplines and especially on the work of artificial intelligence researchers and psychologists interested in human–robot interactions. Nevertheless, we believe that the findings should be of interest to nurses as they can inform current and future robotic developments that will inevitably happen in nursing. Not only should nurses engage with such literature, but they should try to influence the development and application of humanoid robots in their field.

It is fairly well established within nursing that a person's cultural background influences his or her views and attitudes on health, illness, and self-care. People expect nurses to be sensitive to their cultural needs. Studies have revealed that the cultural competence of the nurse influences the patient's satisfaction of the care he or she receives and the links between cultural competence and other factors, such as compliance and interpersonal communication.

Not surprisingly, a person's cultural background was related to his or her attitudes towards robots, preferences of robots, and verbal and nonverbal behaviors. We cannot say with certainty which countries feel more positively or more negatively towards robots, and that is possibly due to limitations of the studies reviewed in this article. As previously mentioned, most of the work was conducted with university students, and in very few studies did participants have the chance to interact with a humanoid or animal robot. Looking at online photos or video recordings is different from having a hands-on experience, consistent with the findings of Haring et al. (2016), who reported a change in attitudes after participants interacted with a robot; similar findings have been reported among older people (Stafford et al., 2010). Another explanation for the variable results among countries could be that the results reflect changes in attitudes that parallel the progression of robotic technology or people's experiences with robots. However, comparisons cannot be made, since the studies we reviewed used different methodologies and questionnaires, produced different outcomes, and were examined over time between countries or within the same country.

More consistent results were found with regard to the hypotheses about the influence of culture on humanoid robots' communication styles, use of language, and nonverbal behaviors, such as interpersonal distance and expression of emotions through movements or gestures. As predicted by Hall's theory (Hall, 1990) and Hofstede's cultural dimensions (Hofstede et al., 2010), expected cultural differences were found to govern human–robot interactions. Participants from collectivist societies such as Egypt and Italy sat closer to the robot during their interactions. Furthermore, participants from high-context classified countries such as East Asian cultures preferred an implicit communication style from the robot, whereas those from a low-context classified country such as Germany preferred an explicit, straightforward communication style.

The use of existing theoretical frameworks can facilitate our understanding of relationships, and as robots continue to be part of our lives, it is essential that we guide our future cross-cultural investigations in the field of human–robot interactions by using tested theories. Nursing can draw from existing transcultural nursing theories and models of cultural competence (e.g., Papadopoulos, 2006; Srivastava, 2007). The evidence reviewed in this article provides a starting point for understanding the importance of culture to human–robot acceptance and interaction, but more research is needed before the benefits of this knowledge can be applied to health care. Robust studies that explore the influence of culture among older adults from different cultural groups are particularly needed. One can argue that the mounting evidence regarding changing demographics (especially in the developed world) and the huge challenges that societies face in caring for the old and very old populations with complex needs and chronic health problems demand urgent attention. Research is also needed in the actual development of robots and how this can impact human–robot interaction. Barua, Sramon, and Heerink (2015) argued that the behavior of the robot is a reflection of the creators' values, which means that if we desire robots to be effectively integrated into health care, we ought to aim for the creation of culturally competent and compassionate robots. Our research is focusing on the development of such a robot, guided by the Papadopoulos (2006) model of cultural competence, and supplemented by the national and cultural dimensions of Hofstede et al. (2010) and Hall's (1973, 1976) cultural iceberg notion. A major challenge for humans is the avoidance of stereotypes, discrimination, and the implementation of effective communication among diverse groups. In our current research, these issues form the heart of the development of guidelines for the programming of robots (Papadopoulos, Sgorbissa, & Koulouglioti, 2017). Effective and appropriate communication in a multicultural environment is paramount to patient safety; therefore, continuing to investigate the importance of culture on the human–robot relationship is clinically significant. As highlighted in this review, a person's cultural background influences many behaviors, and not only acceptance of robotic technology. The current evidence indicates that preferences about a robot's appearance, the general attitudes towards the use and application of robots, along with verbal and nonverbal communication styles are impacted by culture. Nurses are practicing in a diverse environment that constantly changes. Researchers, in the integration and use of any new intervention, such as the use of robots in the field of health care, cannot ignore the main stakeholders and their characteristics.

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Clinical Resources

- Research Papers on the robotic Pet seal Paro. www.parorobots.com/whitepapers.asp and https://www.cdc.gov/niosh/topics/robotics/default.html
- CDC - Robotics - NIOSH. www.cdc.gov
- Robots are machines or automated technologies that are capable of performing a series of actions to do everything from drive cars to perform patient surgery. Robots have existed in the workplace for quite some time, but their presence on jobsites is increasing, as are their capabilities. and http://caressesrobot.org/en/project and https://medlineplus.gov/magazine/issues/spring16/articles/spring16pg8-10.html

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