International Journal of Social Robotics (2026) 18:51
https://doi.org/10.1007/s12369-026-01387-x

REVIEW

Diversity and Culture in Social Robotics: A Scoping Review

Lorenza Saettone[1] · **Antonio Sgorbissa**[1] · **Carmine Tommaso Recchiuto**[1]

Received: 18 January 2024 / Revised: 5 January 2026 / Accepted: 27 February 2026 / Published online: 16 March 2026

Abstract
This review explores how cultural relativism affects the adoption and perception of robots, drawing conclusions that can be used to mitigate biases and design robots that incorporate cultural diversity. Indeed, several aspects (like religion, pragmatics, appearance, application areas) need to be considered and implemented to ensure a more pleasant interaction with humans. We show that culture is in itself a broad concept that covers various aspects: verbal behavior, nonverbal behavior, design, and application areas. It could intervene as a response and interpretation strategy when there is a clear reference to a social background in the task to shorten the adaptation. It is a cost-saving principle, a heuristic.

Keywords Diversity-aware robotics · Culture-aware robotics · Social robotics · Scoping review

1 Introduction

Social robotics is a field focused on designing robots that interact and communicate with humans in social or collaborative ways. Social robots are designed to be empathetic, responsive, and capable of interpreting human emotions and cues, making them suitable for roles that require human-like interactions and assistance. Social robotics is considered a 'disruptive technology': it is expected to shape how we are in the world and with others in the coming years [1, 2]. The application areas are varied: from entertainment to education, from medical assistance to companionship, and from help in work contexts to domestic support. After all, Western countries are an increasingly elderly society, and the use of social robots may solve the shortage of specialized caregivers for the assistance and companionship of otherwise isolated older adults [3]. Furthermore, service robots have proven to be an opportunity for training and teamwork [4].

However, it is not easy to design social robots that also work from a human, social point of view because the insertion of technology into the social meshwork is never only dependent on engineering and, thus, on purely technical, objective aspects. Meaning, acceptability, ease of use, fear, or interest in these kinds of artificial agents also depend on subjective differences, one of which is culture. In other words, technologies are also social objects, and it is unthinkable to expect to build universally good robots. To be functional, robots must not only possess physical and engineering standards; they must also function socially. This is why we decided to focus our analysis of diversity on cultural factors: cultural differences profoundly shape how individuals perceive, interact with, and accept robots. While diversity encompasses a range of aspects, including age, prior experiences, disabilities, gender, and language, culture plays a unique role in setting expectations, communication styles, and emotional responses in social interactions. Focusing on cultural diversity, i.e., the variety of cultural norms, traditions, languages, and beliefs that exist among individuals, allows us to generate insights that are crucial for designing social robots that align with users' social norms and values, fostering more meaningful and contextually appropriate interactions across varied cultural settings.

For this reason, roboticists are also investigating cultural diversity from a multidisciplinary point of view. Recently, Mansouri [5] has analyzed the growing role of culture in the field of social robotics, arguing, from his perspective, some limits of incorporating cultural investigations or aspects into robots, where there is no unanimous agreement among the humanities and social sciences. That absence of a definitive consensus has been one of the main critical issues in the use of culture as an analytical variable also by epistemologists [6], as it makes it difficult to establish shared criteria for

✉ Carmine Tommaso Recchiuto
carmine.recchiuto@dibris.unige.it

[1] Università degli Studi di Genova, DIBRIS, RICE Lab, Genova, Italy

observation and, consequently, to guarantee the replicability of studies when different researchers do not know precisely ‘where to look’. Actually, the lack of a unanimous definition for culture is also due to the fact that it is, in itself, a large concept that involves multiple aspects; therefore, this fuzziness represents its strength. This viewpoint of “conceptual flexibility” [7] represents an advantageous engineering element, which we will debate deeply later in the Discussion. Starting from Elisabetta Lalumera’s theorization [7], we moved to the concept of “cultural flexibility”, referring to the ability to apply cultural concepts as adaptive strategies in varying contexts, allowing individuals to respond dynamically to social demands. Culture, therefore, provides a set of flexible strategies that can be adapted and employed based on situational requirements, particularly when tasks necessitate social engagement. This flexibility supports the idea of cultural relativism, or perspectivism, i.e., the idea that cultural elements are understood not as fixed attributes but as adaptable practices that are context-dependent. This view is further elaborated in recent research [8, 9], which examines how representation itself organizes reality, underscoring the inherent dynamism of cultural frameworks in shaping human perception and action.

We conceptualize Culture as a sort of “perception of belonging”. As psychology has shown since William James [10] and George Herbert Mead [11], individuals shape their own selves through multiple and interrelated dimensions, which include individual (personality), material (the body), but also social and cultural aspects. The Social Self can be understood as the construct that emerges from interactions, other’s feedback, language (verbal and nonverbal), roles, and the sharing of meanings within groups to which the individual feels they belong. Such affiliations are based on differentiated recognitions of bonds that may relate, among other things, to gender (as culturally defined), religion, politics, ideology, beauty, arts, occupation, or nationality.

Here, we can briefly retrace the history of the term “culture” [12]. During the Romantic period, culture was closely identified with nationhood and language. This marked the first step toward conceiving culture as a collective heritage that could be transmitted across generations, rather than as an elitist and strictly individual attribute, as it had been previously understood. In this historical phase, culture was viewed as a unified and distinctive expression of a people, bound not only by political borders but also by a shared spirit of identity encompassing language, traditions, lifestyles, and common symbolic forms: elements that, in turn, served to justify those borders. From this perspective, culture became the foundation of national identity and a prerequisite for political self-determination. It is no coincidence that Italy and Germany achieved national unification in the nineteenth century, driven by Romantic discourses that fostered a sense of shared belonging and the aspiration for an independent homeland in which to nurture and preserve this collective bond.

Over time, however, the concept of culture has undergone a gradual process of pluralization. From a relatively stable and monolithic entity tied to written, normative, and linguistic heritage, it has evolved into a dynamic ensemble of practices, meanings, and relationships. Anthropology [12] has broadened its scope far beyond written and monumental traditions, incorporating implicit practices and rituals and embracing forms of belonging that may transcend spatial, temporal, and national boundaries. In this perspective, it is more appropriate to speak of cultures in the plural, as fluid and situated configurations generated by religious, professional, political, or media-based ties, as well as by influences of language, both verbal and nonverbal.

Following Karl Popper’s methodological individualism [13], universal concepts (such as the category of “culture” itself) should be regarded as theoretical simplifications and auxiliary constructs. These lack an independent ontological existence apart from individuals yet remain heuristically valuable as they allow for the abbreviation of otherwise protracted descriptions of human action. From this perspective, collective entities possess no intrinsic reality; they acquire significance only insofar as individuals recognize them (albeit not necessarily in a fully conscious manner) and incorporate them into their practices, representations, and behaviors, thereby allowing these entities to orient their actions. Such concepts thus attain an operational reality solely through the individual actions, perceptions, and conducts that presuppose their existence. It is therefore in individual actions, rather than in any abstract collective totality, that nations, religions, and cultures derive their meaning and produce observable effects on the individuals themselves. This is not a vicious circle, as one might presume. It is precisely what Schleiermacher, Dilthey, and Gadamer called the “hermeneutic circle” [14]: a productive and inevitable interplay between part and whole, in which pre-understandings guide interpretation while being refined by it. The same reasoning applies to the charge of circularity according to which culture itself would be a culturally determined concept [15]: since no observation can ever be free from theoretical pre-understandings, the very myth of a neutral gaze untouched by preconceptions is itself a prejudice, the product of a particular theoretical and cultural tradition. Hence, cultures do not exist as autonomous entities but emerge as the outcome of processes of recognition and identification, until they become unconditional reflexes, habits of action, not necessarily under the constant control of self-awareness. Anyway, the boundaries of belonging persist only as long as individuals perceive themselves as members of these collectives and attribute relevance to such affiliations in their everyday actions; thus, this explains how cultures change, keeping the activity of individuals, without being passively determined by any macro-categories.

In this scoping review, we also aim to address some of the criticisms raised in [16], where the author has examined ethical risks associated with the representation, recognition, and reasoning of human identity characteristics in robots, discussing the ethical implications of allowing robots to understand or generate descriptions of people based on culture, finally highlighting the dangers related to the possibility that robots might perpetuate stereotypes or discrimination. Indeed, this review work tries to understand the boundary between *Culture as a heuristic* and *Culture as a bias*.

We believe that viewing *Culture as a heuristic* enables to exploit the flexible view of cultural determinism, along with other conditioning factors, incorporated into the human cognitive loop (perception - planning – action), which, overall, can lead to a set of ready-to-use action strategies, in particular in situations of limited information and insufficient time. In this case, each cultural conditioning is seen as eliminable in favor of other strategies, depending on the task, i.e. being defined as weak relativism, elastic and dynamically adaptable, thus not rigid and ineluctable (as in the case of *Culture as a bias*). In this context, recent works [9, 17, 18] have tried to propose a robotic implementation that uses cultural competence as a dynamic heuristic, based on probabilistic, and modifiable in light of new data, models of belief and knowledge. This approach overcomes the risk of prejudice and racism, keeping culture as a guideline, a useful heuristic for selecting plans in social interactions and anticipating others' beliefs to be assessed along the way.

The increasing interest in culture in its various facets by the robotics community is also evidenced by the recent work of Mansouri [5]. Among other examples, he includes the CARESSES project [19], coordinated by the University of Genoa and funded by the European Commission and the Ministry of the Interior and Communications of Japan, is an instance of this interest of roboticists in culture. The term Culture-Aware Robots is central here, and the aim was precisely to develop an elderly care robot that can adapt the way it speaks and behaves to the culture of the person being cared for. Another example we can add is the RobOntics [20] workshop held within the Roman 2023 conference in Korea. Once again, the central theme was culture, and on the workshop's website, it is stated: "This edition of RobOntics is particularly interested in the problem of modeling culture and social scenarios (broadly understood) via ontology and other knowledge representation techniques." All of this attests to the growing interest in the theme of culture in robotics.

Like Mansouri's paper, the proposed work also aims to analyze, through the method of scoping review, the growing interest in culture within robotics: in which areas research has been concentrated and what limitations, if any, exist. The following scoping review aims to discover how relativism, especially cultural relativism, impacts the adoption and perception of robots by investigating these issues' state-of-the-art. The term relativism refers to the philosophical idea that truth and moral values are not absolute but rather shaped by cultural, social, or individual perspectives. Cultural relativism emphasizes understanding and evaluating beliefs and practices within the context of their originating culture, rather than through external and universal standards, fostering an appreciation for diversity and reducing ethnocentric bias. The aim is to draw conclusions that can also function as guidelines for further studies on the subject, to mitigate bias, and to design robots in which diversity, and specifically cultural diversity, is included by design. Relativism is often criticized for lacking scientific rigor and factual grounding, as it abandons fixed criteria of judgment in favor of perspectives dependent on the observer's viewpoint. However, as outlined above and further explored below, this concern is mitigated when the supported a weak form of relativism—that is, a context-dependent framework influenced by specific tasks and adaptable to evolving requirements. In the following, Sect. 2 will report the method followed for the scoping review, with a description of the inclusion and exclusion criteria. Section 3 presents the results derived from the study, which are discussed in Sect. 4. Finally, Sect. 5 concludes the manuscript by proposing possible future research perspectives.

2 Methods

For all the reasons mentioned above, in recent years roboticists have started asking themselves what cultural and personal characteristics must be taken into account to create designs, interfaces, and ontologies for diversity-aware machines, i.e., robots designed to recognize, understand, and adapt to diverse human cultural, social, and individual characteristics. In the following scoping review, we have narrowed the focus to papers that have taken "cultural diversity" as a variable within the HRI (Human Robot Interaction), discussing the results and putting forward hypotheses and possible future research.

One of the main findings emerging from the literature (and a methodological premise of this review) is that cultural differences in HRI are most often operationalized through participants' country of origin, which is used as a proxy for culture. Although this choice is theoretically reductive, it reflects pragmatic constraints of empirical research:

nationality is an observable, institutionally defined, and easily categorizable variable that enables relatively stable and replicable comparisons within experimental HRI settings. Moreover, national contexts (through educational systems, media narratives, technological histories, and regulatory frameworks) contribute to shaping shared technological imaginaries and interaction norms that influence how robots are perceived and evaluated. Importantly, such imaginaries are not understood here as rigid or deterministic, but as probabilistic and historically situated frameworks. This review therefore treats the persistent culture–nationality equation not as a theoretical endorsement, but as an empirical pattern that highlights the methodological challenges inherent in studying culture in HRI. In other words, this review does not assume that nationality-based comparisons are equivalent to cultural differences. However, its goal is to map and critically analyze how "culture" is currently considered within the social robotics and HRI literature, including the widespread use of nationality as a pragmatic proxy.

The scoping review approach used in this study is primarily based on the Arksey and O'Malley framework for scoping reviews [21] and the subsequent recommendations proposed by Colquhoun et al. [22] and Levac et al. [23]. Essentially, a scoping review is a widely accepted method to determine the extent, range, and nature of research conducted in a particular field. It serves to consolidate and organize knowledge when the existing literature on a topic is complex or diverse. This type of review is crucial for defining the research scope, exploring various approaches and methods employed in the field, and mapping the current state of research in a more manageable way, with the ultimate outcome of summarizing and disseminating research evidence [15, 24].

To conduct this scoping review, we used the 'Scopus' database and Web of Science Database, and we entered the following search key: TITLE-ABS-KEY (('diversity aware' OR 'cultural values' OR 'cross-cultural study' OR 'cultural differences' OR 'cultural background') AND (robot OR 'technology' OR 'artificial intelligence')). The inclusion of broad terms such as "technology" and "artificial intelligence" was intentional. Several cultural models, perception systems, and multimodal AI agents relevant to social robotics are often developed and evaluated outside embodied robotic platforms, and are only later integrated into social robots. By initially including AI-based studies on cultural recognition, multimodal interaction, or adaptive agents, the review aimed to capture foundational work that, while not originally implemented on robots, is compatible with or has informed subsequent developments in social robotics. The subsequent screening phase allowed us to retain only those contributions with clear relevance to human–robot interaction. This initial search resulted in a total of 628 papers for Scopus and 3697 Documents for Web of Science. Moreover, to also potentially include gray literature in our analysis, we also integrated the Google Scholar database, using the first 200 references as sorted in the relevance ranking [24]. Afterward, the search process was refined following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (http://prisma-statement.org), as suggested by Pham et al. [25]. Based on these guidelines, at a first screening stage, one researcher reviewed the titles and abstracts of papers, including only papers written in English. Moreover, this preliminary screening phase led to the removal of duplicates, papers not related to the topic, non-reviewed books and book chapters, presentation, as well as theses, reports and opinion pieces. This gave 588 papers which underwent further screening: this phase was conducted independently by two researchers, leading to the selection of 95 unique documents, based on the following inclusion and exclusion criteria (Fig. 1):

Inclusion Criteria:

- Papers written in English;
- Papers fully accessible;
- Papers including the relevant search terms as previously defined;
- Papers having as the main topic the relationship between culture (and/or diversity) and robotics.

Exclusion Criteria:

- Studies in which robots promote cultural heritage;
- Studies in which AI is used to analyze and categorize data to uncover cultural or diversity traits;
- Studies in which social robotics[1] is not the main focus;
- Studies where culture is only mentioned in regulations;
- Studies analyzing a trait that seems more individual than cultural;
- Studies in which the cultural/diversity aspect is very marginal or at least presented as a conclusive hypothesis for future studies;
- Repeated papers and book chapters.

Please note that in this phase, each researcher assessed the papers based on the inclusion and exclusion criteria, and their independent evaluations were compared. A third researcher was consulted to resolve any disagreements regarding paper eligibility.

[1] We clarify here that, by using the term *social robots*, we are specifically referring to robots that are designed, programmed, or intended to engage in meaningful interactions with humans. These interactions can take various forms, such as verbal communication, nonverbal gestures, emotional expression, or collaborative behavior, and are aimed at fostering a sense of social presence, understanding, or cooperation between the robot and its human counterparts.

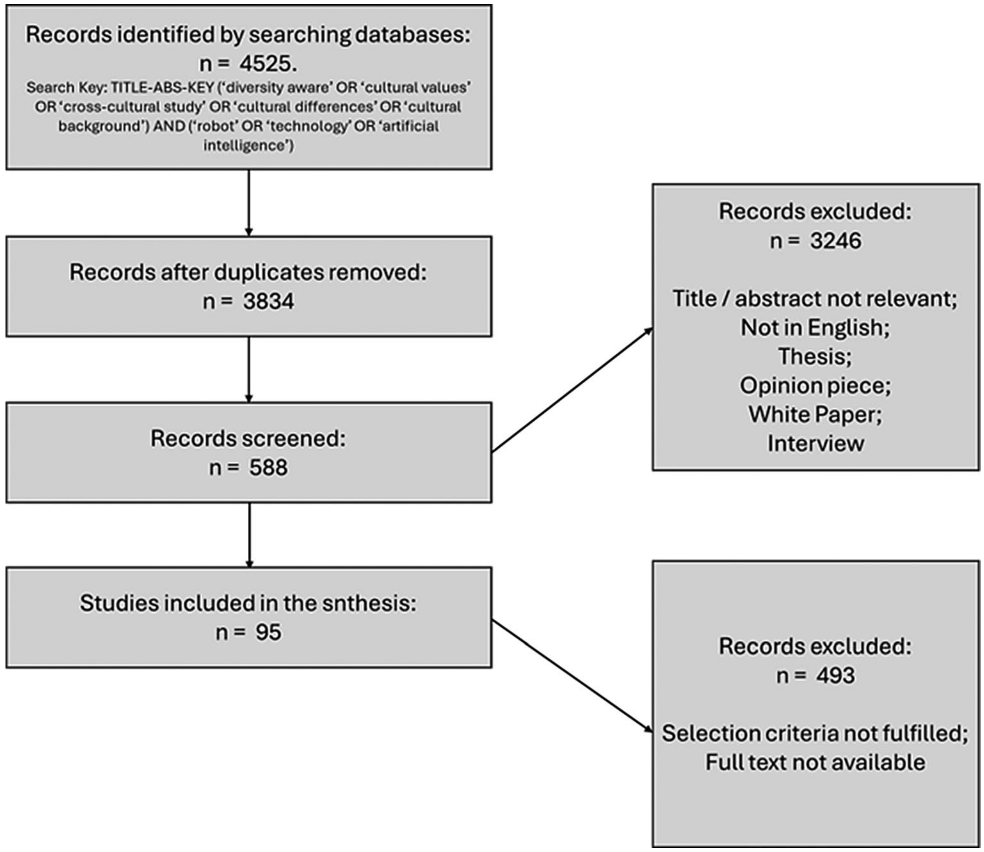

Fig. 1 PRISMA screening process for identified papers

3 Results

All 95 resulting papers were published in a time range from 2007 to 2023, with peaks in 2017, 2021, and 2023, showing a positive trend in the investigation of these aspects. As mentioned in the Introduction, despite taking into account both "diversity" and "culture" during the search, almost all selected papers primarily emphasize the cultural aspect within the wider concept of diversity awareness. Hence, in the analysis of the results, we will mainly refer to the concept of "cultural diversity". At a geographic level, the countries that have researched the role of culture in robotics are Japan in the first place, followed by the USA and the Netherlands. Many studies have been also conducted in Germany, the UK, China, Italy, Austria, France, and New Zealand. Again, as highlighted in the introduction and in the methodology sections, cultural differences in HRI are often operationalized through participants' country of origin. Nationality is frequently used as a proxy for culture; in other occasion studies consider other parameters of selection like Hosftede's categories [26], religion, entire continents, indicating the multifaceted nature of culture.

To analyze the documents, a thematic analysis has been done following the guidelines of Levac et al. [23], identifying cross-cutting lines, valid for the purpose of understanding the results and thus for the final discussion, and not clear-cut categories. In the following sections, we have hence described the resulting papers focusing on: the possible cultural (or national) aspects underlying the way in which humans perceive social robots (3.1, 3.2); scientific and technological methodologies to embed cultural differences in social robots (3.3); the experimental validation of those approaches, in terms of how robots are perceived able of communicating (verbally and non-verbally) according to culture-aware aspects (3.4); the way in which cultural differences reflect the acceptance, trust, design, and usage preferences of robots in general (3.5).

The thematic analysis resulted in five main themes. Owing to the intrinsically fuzzy and multidimensional nature of culture, these themes should not be understood as strictly mutually exclusive categories. Partial overlap among them is expected and reflects the complexity of cultural phenomena in human–robot interaction, rather than a lack of conceptual clarity.

The theme "Animistic and Religious Backgrounds" includes studies that explicitly address belief systems, worldviews, or spiritual frameworks influencing how robots are perceived, attributed agency, or morally evaluated.

"National Technological History" refers to contributions examining how historical trajectories of technological development, innovation, and societal attitudes toward technology within specific national contexts shape expectations and acceptance of robots; how national media and political speeches contribute to shape the imaginary of people to frame innovation and consequently use it.

“Implementation Aspects” encompasses studies proposing concrete design choices, architectures, algorithms, or system-level solutions aimed at accounting for cultural variability in human–robot interaction, without explicitly explaining, discussing results.

The “Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities” section focusses on papers that examine how robots equipped with culture-aware algorithms in verbal and non-verbal communication, and language pragmatics rules may have impacts on HRI.

Finally, “Trust and Preferences” refers to empirical investigations of users’ evaluations, attitudes, acceptance, and behavioral responses toward robots in general, not those equipped with cultural-aware proactive behaviors. These papers measure general trust, likability, and preference, analyzed in relation to culturally differentiated groups.

The thematic analysis followed a multi-step coding process - open coding, axial coding, and selective coding - using the web-based application Dedoose (http://www.dedoose.com). In the first phase, meaningful units were identified and labeled by two researchers, allowing categories to emerge from the data (open coding). These initial codes were then grouped, refined, and combined into wide themes (axial coding). Conceptually stable thematic patterns were subsequently organized into higher-order conceptual themes. During selective coding, the themes were further integrated and refined [27]. Finally, the findings were validated and consolidated through discussions involving all members of the research team.

For example, we found a number of papers (e.g. [28–31]), related to adaption strategies for social robots dealing with users identifying themselves with a specific culture. The *open coding* approach led to identifying some labels (e.g., Cultural Norms, Robot Adaption, Greeting, Emotion Detection), that were refined during the *axial coding* process (e.g., Verbal Communication Adaptation, Non-Verbal Communication Adaptation), to be finally grouped in the main themes Learning and Adaptation and Universal vs. Culturally Variable Phenomena, both dealing with Implementation Aspects of Diversity and Cultural competent robots.

The summary of the coding analysis is shown in Fig. 2, while a comprehensive list of all papers identified, together with the year of publication, the main theme (s) and the main findings are shown in Table 1.

Given the exploratory aim of scoping reviews, formal inter-rater reliability metrics were not computed; instead, coding consistency was ensured through iterative comparison, discussion, and third-author arbitration until consensus was reached.

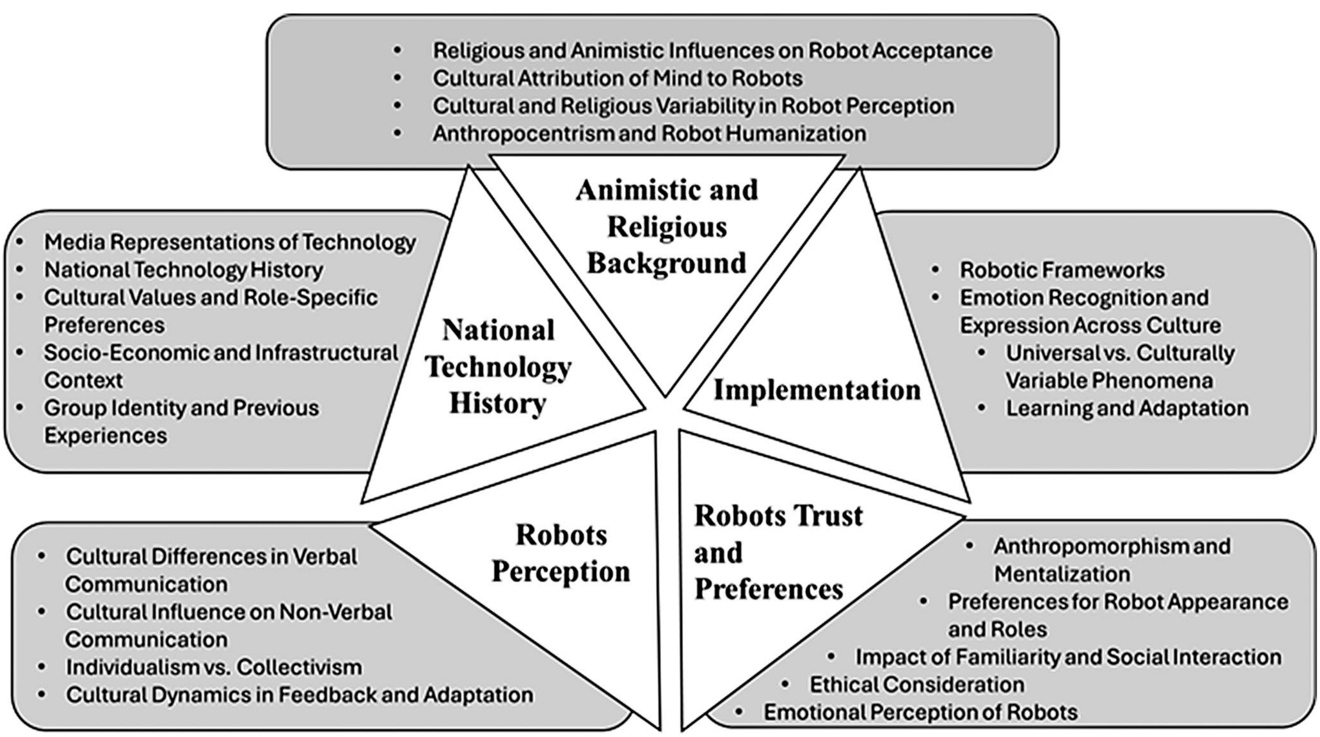

Fig. 2 Main themes and subthemes identified in the screened papers

Table 1 Table of papers selected for the review, outlined according to year, author, title, theme and results

Year	Authors	Title	Theme	Results
2023	Cooney, M., Shiomi, M., Duarte, E. K., & Vinel, A.	A broad view on robot self-defense: Rapid scoping review and cultural comparison [32]	Cultural Differences in Robot Trust and Preferences	The work examines the cultural differences in the acceptability of robot use of force, with particular attention to how trust in self-defense robots varies between Japanese and American participants. The analysis emphasizes how cultural perceptions influence trust in robots and suggests that self-defense robots should be designed with cultural expectations in mind
2023	Ohkura, M., Sugaya, M., Sripian, P., Laohakangvalvit, T., Chiba, H., Berque, D.	Design and implementation of kawaii robotic gadgets in virtual spaces by Japanese and American University students in a remote collaboration project [33]	Cultural Differences in Robot Trust and Preferences	The paper deals with the influence of the concept of "kawaii" in robotic design, showing how students from different cultures can appreciate and understand this concept, possibly improving the perception and acceptance of robots.
2023	Abdelhakim A.S., Abou-Shouk M., Ab Rahman N.A.F.W., Farooq A.	The fast-food employees' usage intention of robots: A cross-cultural study [34]	Cultural Differences in Robot Trust and Preferences	Among the cultural dimensions, Uncertainty Avoidance, masculinity, individualism, and long-term orientation have effects on the willingness of robot's adoption.
2023	Papadopoulos, I., Koulouglioti, C., Lazzarino, R., Ali, S., Wright, S., Martín-García, Á., … Nissim, S.	Views about perceived training needs of health care professionals in relation to socially assistive robots [35]	Cultural Differences in Robot Trust and Preferences	The work identifies training needs for health-care professionals in the use of socially assistive robots, highlighting cultural differences in training requirements and perceptions of robot safety and capability.
2023	Pitardi V., Bartikowski B., Osburg V.-S., Yoganathan V.	Effects of gender congruity in human-robot service interactions: The moderating role of masculinity [36]	Cultural Differences in Robot Trust and Preferences	In cultures with high level of masculinity, feelings of comfort and control are elicited by consumers-robots gender congruity.
2023	Marchesi S., Abubshait A., Kompatsiari K., Wu Y., Wykowska A.	Cultural differences in joint attention and engagement in mutual gaze with a robot face [37]	Cultural Differences in Robot Trust and Preferences	Singaporean participants showed a higher tendency to engage in joint attention with an artificial agent, relative to Italian participants, while the latter rated as more engaging the avatar during the eye contact experiments, relative to no eye contact.
2023	Chi O.H., Chi C.G., Gursoy D., Nunkoo R.	Customers' acceptance of artificially intelligent service robots: The influence of trust and culture [38]	Cultural Differences in Robot Trust and Preferences	Long-term orientation has been found to exhibit significant effects on anthropomorphic robot acceptance.
2023	Oh J.-Y., Bennett C.C.	The Answer lies in User Experience: Qualitative Comparison of US and South Korean Perceptions of In-home Robotic Pet Interactions [39]	Cultural Differences in Robot Trust and Preferences	American participants were more likely to focus on the interactive experience itself, whereas Korean participants focused more on critiquing technical aspects of the technology.
2023	Dang J., Liu L.	Do lonely people seek robot companionship? A comparative examination of the Loneliness–Robot anthropomorphism link in the United States and China [40]	Cultural Differences in Robot Trust and Preferences	A negative link between loneliness and robot anthropomorphism has been identified in Chinese participants, but not in American participants.
2022	Fraune, M.R., Komatsu, T., Preusse, H.R., Langlois, D.K., Au, R.H.Y., Ling, K., Suda, S., Nakamura, K., Tsui, K.M.	Socially facilitative robots for older adults to alleviate social isolation: A participatory design workshop approach in the US and Japan [41]	Cultural Differences in Robot Trust and Preferences	Definition of a Participatory Design modality in which US and Japanese groups were asked to think of robots to combat loneliness in the elderly. The Western group saw the robot as a tool; Japanese participants as a companion.
2022	Diana, F., Kawahara, M., Saccardi, I., Hortensius, R., Tanaka, A., Kret, M.E	A Cross-Cultural Comparison on Implicit and Explicit Attitudes Towards Artificial Agents [42]	Cultural Differences in Robot Trust and Preferences	Japanese individuals have a more positive explicit attitude towards robots than Dutch individuals, but no evidence exists at the implicit level (when no questionnaires are used).

Table 1 (continued)

Year	Authors	Title	Theme	Results
2021	Alemi, M., Abdollahi, A	A Cross-cultural Investigation on Attitudes Towards Social Robots: Iranian and Chinese University Students [43]	Cultural Differences in Robot Trust and Preferences	Chinese users have a slightly higher average acceptance than the Iranians. Gender and previous experience with the robot seem to have no impact.
2021	Zhang, M., Xu, T., Hardin, J., Cai, J.J., Brooks, J., Green, K.E.	How many robots do you want? A cross-cultural exploration on user preference and perception of an assistive multi-robot system [44]	Cultural Differences in Robot Trust and Preferences	Differences in terms of preferences are identified in the Indian group, but not between the US and Chinese participants - so East vs West is a simplistic classification.
2021	Dang, J., Liu, L.	Robots are friends as well as foes: Ambivalent attitudes toward mindful and mindless AI robots in the United States and China [45]	Cultural Differences in Robot Trust and Preferences	Slight differences are identified between China and the US regarding attitudes towards robots with high or low mental capabilities.
2019	Bröhl, C., Nelles, J., Brandl, C., Mertens, A., Nitsch, V.	Human–Robot Collaboration Acceptance Model: Development and Comparison for Germany, Japan, China and the USA [46]	Cultural Differences in Robot Trust and Preferences	Comparing attitudes in Germany, Japan, China, and the USA, cross-cultural differences in human-robot collaboration in industrial work environments are influenced by factors like automation, technology usage, robot addiction, and data protection laws than any East vs West Culture.
2019	Brito, I.V., Freire, E.O., Carvalho, E.A.N., Molina, L.	Analysis of cross-cultural effect on gesture-based human-robot interaction [47]	Cultural Differences in Robot Trust and Preferences	Culture doesn't significantly impact gesture-based human-robot interaction, except for music-related gestures which have a more robust cultural reference.
2019	Vannucci, F., Sciutti, A., Lehman, H., Sandini, G., Nagai, Y., Rea, F.	Cultural differences in speed adaptation in human-robot interaction tasks [48]	Cultural Differences in Robot Trust and Preferences	The speed of adaptation of Japanese and Italian participants when imitating a robot in a joint task of placing Lego bricks in a box does not seem to depend on cultural differences.
2018	Bernotat, J., Eyssel, F.	Can('t) Wait to Have a Robot at Home? - Japanese and German Users' Attitudes Toward Service Robots in Smart Homes [49]	Cultural Differences in Robot Trust and Preferences	Differences in the usage of robots were assessed between Japanese and German participants. Both perceived the two robots as machines, even if Japanese subjects tent to anthropomorphize the robot.
2018	Tay, T.T., Low, R., Loke, H.J., Chua, Y.L., Goh, Y.H.	Uncanny valley: A preliminary study on the acceptance of Malaysian urban and rural population toward different types of robotic faces [50]	Cultural Differences in Robot Trust and Preferences	There is no evidence of a difference in the Uncanny Valley perception due to internet exposure: the Uncanny Valley occurs similarly among urban and rural dwellers in Malaysia.
2017	Bruno, B., Chong, N.Y., Kamide, H., Kanoria, S., Lee, J., Lim, Y., Pandey, A.K., Papadopoulos, C., Papadopoulos, I., Pecora, F., Saffiotti, A., Sgorbissa, A.	Paving the way for culturally competent robots: A position paper [51]	Cultural Differences in Robot Trust and Preferences	To manage cultural competence in robotics, pre-understandings can be provided by experts to purge the notions of bias.
2017	Nomura, T.	Cultural differences in social acceptance of robots [52]	Cultural Differences in Robot Trust and Preferences	Japan seems to have more positive attitudes towards robots.
2017	Rudovic, O., Lee, J., Mascarell-Maricic, L., Schuller, B.W., Picard, R.W.	Measuring engagement in robot-assisted autism Therapy: A cross-cultural study [53]	Cultural Differences in Robot Trust and Preferences	Culture (e.g., Japan and Serbia) can have an influence in attracting the attention of children with autism: results show a significant difference between cultures, but require further analysis.
2015	Haring, K.S., Silvera-Tawil, D., Takahashi, T., Velonaki, M., Watanabe, K.	Perception of a humanoid robot: A cross-cultural comparison [54]	Cultural Differences in Robot Trust and Preferences	Japan seems to have more positive attitudes towards robots compared to other cultures.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2015	Destephe, M., Brandao, M., Kishi, T., Zecca, M., Hashimoto, K., Takanishi, A.	Walking in the uncanny valley: Importance of the attractiveness on the acceptance of a robot as a working partner [55]	Cultural Differences in Robot Trust and Preferences	Attractiveness influences the acceptance of robots through cultural differences.
2015	Conti, D., Cattani, A., Di Nuovo, S., Di Nuovo, A.	A cross-cultural study of acceptance and use of robotics by future psychology practitioners [56]	Cultural Differences in Robot Trust and Preferences	A significant difference in the intention to use the robot for psychological practice has been here identified: Italians are more positive than British. However, it doesn't necessarily mean a real willingness to use it.
2015	Lee, H., Kang, H., Kwak, S.S., Lee, J., Kim, M.-G., Kwon, J.	How people perceive human-and product-like robots: Cross-cultural analysis between Japan and Korea [57]	Cultural Differences in Robot Trust and Preferences	Differences between the perception of human-like and product-like robots in Korea and Japan have been here underlined; also in this case, however, differences are not necessarily correlated with the willingness to buy a robot.
2015	Fraune, M.R., Kawakami, S., Šabanović, S., De Silva, P.R.S., Okada, M.	Three's company, or a crowd?: The effects of robot number and behavior on HRI in Japan and the USA [58]	Cultural Differences in Robot Trust and Preferences	Japan seems to have more positive attitudes towards robots, also preferring interacting with robots in groups.
2014	Torta, E., Werner, F., Johnson, D.O., Juola, J.F., Cuijpers, R.H., Bazzani, M., Oberzaucher, J., Lemberger, J., Lewy, H., Bregman, J.	Evaluation of a Small Socially-Assistive Humanoid Robot in Intelligent Homes for the Care of the Elderly [59]	Cultural Differences in Robot Trust and Preferences	No significant cultural differences between elderly Israelis and Austrians were here identified.
2014	Shahid, S., Krahmer, E., Swerts, M.	Terms and conditions Privacy policy Child-robot interaction across cultures: How does playing a game with a social robot compare to playing a game alone or with a friend? [60]	Cultural Differences in Robot Trust and Preferences	Differences between Dutch and Pakistani children were assessed in the proposed experiments. Pakistani children showed some culture-specific gestures during interaction and were disappointed because iCat did not pray with them.
2014	Lee, H.R., Šabanović, S.	Culturally variable preferences for robot design and use in South Korea, Turkey, and the United States [61]	Cultural Differences in Robot Trust and Preferences	Koreans believed that robots should have social roles; Americans saw robots as tools.
2013	Giuliani, M., Petrick, R.P.A., Foster, M.E., Gaschler, A., Isard, A., Pateraki, M., Sigalas, M.	Comparing task-based and socially intelligent behaviour in a robot bartender [62]	Cultural Differences in Robot Trust and Preferences	A bartender robot should have also conversational and social competencies, independently of the culture of the customers.
2012	Coeckelbergh, M.	Can we trust robots? [63]	Cultural Differences in Robot Trust and Preferences	The paper explores the concept of trust in robots, influenced by cultural norms.
2012	Mavridis, N., Katsaiti, M.-S., Naef, S., Falasi, A., Nuaimi, A., Araifi, H., Kitbi, A.	Opinions and attitudes toward humanoid robots in the Middle East [64]	Cultural Differences in Robot Trust and Preferences	Studies conducted at Dubai's Gitex exhibition revealed that cultural background, religion, age, and education impact the preferences about robots.
2012	Weiss, A., Van Dijk, B., Evers, V.	Knowing me knowing you: Exploring effects of culture and context on perception of robot personality [65]	Cultural Differences in Robot Trust and Preferences	Task-dependence and cultural-background impact on attribution of personality traits for socially interactive robot.
2011	Shahid, S., Krahmer, E., Swerts, M., Mubin, O.	Who is more expressive during child-robot interaction: Pakistani or Dutch children? [66]	Cultural Differences in Robot Trust and Preferences	Children's emotional response to iCat revealed that children from Pakistan were much more expressive than their Dutch counterparts.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2010	Rau, P.L.P., Li, Y., Li, D.	A cross-cultural study: Effect of robot appearance and task [67]	Cultural Differences in Robot Trust and Preferences	Chinese, Korean, and German cultures impact preferences on robot appearance and task. The study took into account is a culture is collectivistic\ individualistic, female\male, high\low context.
2009	Coeckelbergh, M.	Personal robots, appearance, and human good: a methodological reflection on roboethics.[68]	Cultural Differences in Robot Trust and Preferences	The work analyses how robots influence human quality of life through a methodological approach that shifts from analyzing the robots themselves, to analyzing culturally situated human-robot interactions, emphasizing the importance of appearance, experience, and imagination.
2008	Bartneck, C.	Who like androids more: Japanese or US Americans? [69]	Cultural Differences in Robot Trust and Preferences	Japanese users tend not to accept robots and trust them; Americans seem immune to Uncanny Valley.
2007	Nomura, T., Kanda, T., Suzuki, T., Han, J., Shin, N., Burke, J., Kato, K.	Implications on humanoid robots in pedagogical applications from cross-cultural analysis between Japan, Korea, and the USA [70]	Cultural Differences in Robot Trust and Preferences	Americans view robots as technological products, Koreans for communication and hospital work. Japanese view robots as beneficial to society and accept them in nursing and educational activities.
2023	Lubitz, A., Gutzeit, L., & Kirchner, F.	CoBaIR: A python library for context-based intention recognition in human-robot-interaction [71]	Implementation Aspects	The work introduces a Python library to recognize intentions based on cultural contexta.
2021	Gasteiger, N., Hellou, M., Ahn, H.S.	Factors for Personalization and Localization to Optimize Human–Robot Interaction: A Literature Review [28]	Implementation Aspects	Robot localization for proxemics and expressions may improve human acceptance during human-robot interaction, with algorithms that map similarities to make adaptation faster.
2020	Recchiuto, C.T., Sgorbissa, A.	A Feasibility Study of Culture-Aware Cloud Services for Conversational Robots [72]	Implementation Aspects	Feasibility of using the Cloud system for culturally sensitive robots.
2018	Rudovic, O., Utsumi, Y., Lee, J., Hernandez, J., Ferrer, E. C., Schuller, B., & Picard, R. W.	CultureNet: A Deep Learning Approach for Engagement Intensity Estimation from Face Images of Children with Autism [73]	Implementation Aspects	The work proposes a model to estimate engagement based on cultural data.
2018	Trovato, G., Lucho, C., Paredes, R.	She's electric—the influence of body proportions on perceived gender of robots across cultures [74]	Implementation Aspects	Implementation strategies can be developed to optimize social robot designs based on body proportions. In this case, it looks like there are no cultural differences.
2018	Viet Tuyen, N.T., Jeong, S., Chong, N.Y.	Emotional Bodily Expressions for Culturally Competent Robots through Long Term Human-Robot Interaction [75]	Implementation Aspects	An incremental learning model for the selection of the user's habitual emotional behavior, emphasizing the cultural traits of individuals, has been developed. Gestures were identified by people identifying themselves with the same culture.
2017	Chen, C., & Jack, R. E.	Discovering cultural differences (and similarities) in facial expressions of emotion [76]	Implementation Aspects	Facial expressions can be adapted and recognized based on cultural differences, suggesting approaches applicable to the design of robots that express emotions in a culturally sensitive manner.
2017	Le Quyen Dang, T., Tuyen, N.T.V., Jeong, S., Chong, N.Y.	Encoding cultures in robot emotion representation [29]	Implementation Aspects	By extracting information from visual stimuli and using past experiences, an initially neutral robot can learn the emotional behaviors of the culture it has been immersed in.
2015	Lugrin, B., Frommel, J., & André, E.	Modeling and evaluating a bayesian network of culture-dependent behaviors [77]	Implementation Aspects	A Bayesian network is proposed to simulate culture-specific non-verbal behaviors (e.g., gestures) in robots, highlighting the role of cultural differences in non-verbal communication.
2015	Izui, T., Milleville, I., Sakka, S., Venture, G.	Expressing emotions using gait of humanoid robot [78]	Implementation Aspects	Nao's pace can reveal emotions: France and Japan are different in the prediction of emotions, in particular, fear is usually mistaken for sadness and joy for fear by the French participants.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2015	Trovato, G., Zecca, M., Do, M., Terlemez, Ö., Kuramochi, M., Waibel, A., Asfour, T., Takanishi, A.	A novel greeting selection system for a culture-adaptive humanoid robot [30]	Implementation Aspects	A culture-dependent greeting selection system has been here proposed, by training the robot with cultural-dependent data in a rule-based manner.
2014	Kishi, T., Futaki, H., Trovato, G., Endo, N., Destephe, M., Cosentino, S., Hashimoto, K., Takanishi, A.	Development of a comic mark based expressive robotic head adapted to Japanese cultural background [31]	Implementation Aspects	A robotic head with expressive capabilities has been developed by using the emotional clues typical of Japanese cartoons.
2014	Bennett, C.C., Sabanovic, S., Fraune, M.R., Shaw, K.	Context congruency and robotic facial expressions: Do effects on human perceptions vary across culture? [79]	Implementation Aspects	Context concordance aids human perceptions of emotional expressions which however change among cultures.
2013	Trovato, G., Kishi, T., Endo, N., Zecca, M., Hashimoto, K., Takanishi, A.	Cross-Cultural Perspectives on Emotion Expressive Humanoid Robotic Head: Recognition of Facial Expressions and Symbols [80]	Implementation Aspects	The robot Kobian-R can change and adapt its facial expression to the users' supposed culture, with the help of cartoonish marks. There are differences among Japanese and Western participants in how those expressions are perceived.
2012	Botzheim, J., Obo, T., Kubota, N.	Human gesture recognition for robot partners by spiking neural network and classification learning [81]	Implementation Aspects	A system to recognize human gestures to improve communication with humans, based on RGBD data and spiking neural networks has been here proposed.
2011	Becker-Asano, C., Ishiguro, H.	Evaluating facial displays of emotion for the android robot Geminoid F [82]	Implementation Aspects	Some robot's emotions expressed through facial expressions (e.g., surprise, fear, anger, sadness) are often confused. Cultural differences may be highlighted also in this scenario.
2023	Bächle, T. C.	Faking it deeply and universally? Media forms and epistemologies of artificial faces and emotions in Japanese and Euro-American contexts [83]	Influence of National Technological History in Human-Robot Interaction	Cultural and technological history influences the design of robotic facial expressions.
2023	Grassini, S., & Ree, A. S.	Hope or Doom AI-ttitude? Examining the Impact of Gender, Age, and Cultural Differences on the Envisioned Future Impact of Artificial Intelligence on Humankind. [84]	Influence of National Technological History in Human-Robot Interaction	The paper explores how national differences between the United States and the United Kingdom influence the perception of AI, suggesting that national policies, media, and historical contexts significantly shape attitudes toward AI and robotics.
2023	Yam K.C., Tan T., Jackson J.C., Shariff A., Gray K.	Cultural Differences in People's Reactions and Applications of Robots, Algorithms, and Artificial Intelligence [85]	Influence of National Technological History in Human-Robot Interaction	Historical and religious factors, as well as exposure to technology are identified as the major cultural elements that can influence in determining the acceptance of social robots.
2021	Robert, L. P.	Contextualizing Human-Automated Vehicle Interactions: A Socio-Ecological Framework [86]	Influence of National Technological History in Human-Robot Interaction	The paper examines how cultural context and infrastructure influence interaction with automated vehicles.
2021	Korn, O., Akalin, N., Gouveia, R.	Understanding Cultural Preferences for Social Robots [87]	Influence of National Technological History in Human-Robot Interaction	Participants from Germany and Arab countries show different attitudes towards the roles, skills, appearance, emotional awareness, interactivity, and automation of social robots.
2020	Erden, M. S.	Social Robotics and Engineering Students: Do They Match? Does Culture Matter [88]	Influence of National Technological History in Human-Robot Interaction	The paper highlights differences between the perception of social robotics between students identifying themselves with different cultures.
2019	Turja, T., Oksanen, A.	Robot Acceptance at Work: A Multilevel Analysis Based on 27 EU Countries [89]	Influence of National Technological History in Human-Robot Interaction	Acceptance of robots depends more on the role of the media and the spread of technology than traditions.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2019	Yu, C.-E., Ngan, H.F.B.	The power of head tilts: gender and cultural differences of perceived human vs human-like robot smile in service [90]	Influence of National Technological History in Human-Robot Interaction	Culture-specific head tilts influence the robot's perception of warmth through non-verbal signals.
2007	Bartneck, C., Suzuki, T., Kanda, T., Nomura, T.	The influence of people's culture and prior experiences with Aibo on their attitude towards robots [91]	Influence of National Technological History in Human-Robot Interaction	The cultural background and technological history of a country can have a high impact on robots' acceptance.
2021	Kim, B., Wen, R., Zhu, Q., Williams, T., Phillips, E.	Robots as moral advisors: The effects of deontological, virtue, and Confucian role ethics on encouraging honest behavior [92]	Influence of the Animistic and Religious Background in Human-Robot Interaction	Robots' moral counselors may use deontological, virtue ethics, and Confucian approaches. Deontological robots are found to be persuasive but weak in preventing dishonest actions due to individualism and competition.
2017	Chikaraishi, T., Yoshikawa, Y., Ogawa, K., Hirata, O., Ishiguro, H.	Terms and conditions Privacy policy Creation and staging of android theatre "Sayonara" towards developing highly human-like robots [93]	Influence of the Animistic and Religious Background in Human-Robot Interaction	Robotic behaviors were obtained from real actors and implemented in the humanoid robot. The reception was generally positive.
2017	Kamide, H., Arai, T.	Perceived Comfortableness of Anthropomorphized Robots in U.S. and Japan [94]	Influence of the Animistic and Religious Background in Human-Robot Interaction	The phenomenon of the Uncanny Valley seem to occur more in the Japanese culture, than with American participants.
2023	Williams T.	The Eye of the Robot Beholder: Ethical Risks of Representation, Recognition, and Reasoning over Identity Characteristics in Human-Robot Interaction [16]	Influence of the Animistic and Religious Background on Human-Robot Interaction	The paper analyses he ethical risks of robotic representation and identity recognition linked to cultural characteristics.
2023	Franco A, Roach S.S.	Demographic Factors Affecting Receptivity of Humanoid Robots in Thailand: An Empirical Study [95]	Influence of the Animistic and Religious Background on Human-Robot Interaction	Significant differences are identified between Thais and non-Thais, but also between Chinese Thai and Thais of non-Chinese ancestry. Also, gender significantly affected the perceived usefulness of robots.
2023	Ikari S., Sato K., Burdett E., Ishiguro H., Jong J., Nakawake Y.	Religion-Related Values Differently Influence Moral Attitude for Robots in the United States and Japan [96]	Influence of the Animistic and Religious Background on Human-Robot Interaction	Moral care was found higher in Japan, while higher religious beliefs have a negative influence on moral care for robots among US participants.
2022	Sakura O.	Robot and ukiyo-e: implications to cultural varieties in human–robot relationships [97]	Influence of the Animistic and Religious Background on Human-Robot Interaction	The representation of human relationships with robots in Japan and the West has been evaluated by comparing online images and ukiyo-e, highlighting differences.
2022	Castelo, N., Sarvary, M.	Cross-Cultural Differences in Comfort with Humanlike Robots [98]	Influence of the Animistic and Religious Background on Human-Robot Interaction	Americans are more comfortable with non-humanoid robots (Jibo and Kuri). Uncanny Valley also exists for Americans (discomfort with human-like robot Nadine).
2022	Spatola, N., Marchesi, S., Wykowska, A.	Different models of anthropomorphism across cultures and ontological limits in current frameworks [99]	Influence of the Animistic and Religious background on Human-Robot Interaction	A more or less anthropocentric background is strictly connected to how robots are perceived.
2013	Samani, H., Saadatian, E., Pang, N., Polydorou, D., Fernando, O. N. N., Nakatsu, R., & Koh, J. T. K. V.	Cultural robotics: The culture of robotics and robotics in culture [100]	Influence of the Animistic and Religious Background on Human-Robot Interaction	The paper examines how culture, religious beliefs, and media influence the design and adoption of robots, exploring how robotics may evolve into a shared culture between humans and robots, and how cultural and religious differences (such as those between Japan and Western cultures) impact the acceptance of robotics.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2023	Engwall, O., Cumbal, R., & Majlesi, A. R.	Socio-cultural perception of robot backchannels [101]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Backchannels are perceived differently across distinct cultures. If their management is implemented with a culture-aware perspective, they may influences trust and encourages greater participation from uses.
2023	Bennett C.C., Bae Y.-H., Yoon J.H., Chae Y., Yoon E., Lee S., Ryu U., Kim S.Y., Weiss B.	Effects of cross-cultural language differences on social cognition during human-agent interaction in cooperative game environments [102]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	English participants had more positive speech sentiment and spoke more frequently than Korean ones, also perceiving the avatar as more "chatty".
2022	Seok, S., Hwang, E., Choi, J., Lim, Y.	Cultural Differences in Indirect Speech Act Use and Politeness in Human-Robot Interaction [103]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Cultural differences in politeness expressions also occur in HRI.
2022	Kumar, S., Halloun, S., Itzhak, E., Tractinsky, N., Nimrod, G., Edan, Y.	Exploring the influence of culture and gender on older adults' perception of polite robots [104]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Israelis and Arabs differed in how they perceived the error made by a polite or rude robot.
2021	Marchesi, S., Roselli, C., Wykowska, A.	Cultural Values, but not Nationality, Predict Social Inclusion of Robots [105]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	The more the participants displayed a collectivistic stance, the more they tended to pass the ball to the robot.
2020	Bhavnani, C.V., Rolf, M.	Attitudes towards a handheld robot that learns Proxemics [106]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Proxemic rules provided by culture are used in HRI.
2020	Depka Prondzinska, A., & Fischer, K.	Using Robots to Study the Perception of Feedback Cross-culturally [107]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Cultural differences may influence the perception of positive and negative feedback
2020	Shidujaman, M., Mi, H., Jamal, L.	"I trust you more": A Behavioral Greeting Gesture Study on Social Robots for Recommendation Tasks [108]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Users accept Nao's robotic recommendations more easily if the behavior is designed taking into account cultural differences.
2018	Lugrin, B., Bartl, A., Striepe, H., Lax, J., Toriizuka, T.	Do I act familiar? Investigating the Similarity-Attraction Principle on Culture-specific Communicative behaviour for Social Robots [109]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Japanese students recruited at a university in Germany did not show any discomfort with the individualist robot because they were used to the German culture where they were studying.
2018	Shen, S., Tennent, H., Claure, H., Jung, M.	My telepresence, my culture? An intercultural investigation of telepresence robot operators' interpersonal distance behaviors [110]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Social distancing rules provided by culture can improve human-robot interaction.
2018	Shidujaman, M., Mi, H.	"Which country are you from?" a cross-cultural study on greeting interaction design for social robots [111]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Participants from China, Thailand, Japan, and Bangladesh correctly identified the origin of Nao robot's greeting gesture.
2017	Trovato, G., Eyssel, F.	Mind attribution to Androids: A comparative study with Italian and Japanese adolescents [112]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Japanese users attribute the mind to a greater extent to the robot with Caucasian appeal.

Table 1 (continued)

Year	Authors	Title	Theme	Results
2017	Mussakhojayeva, S., Sandygulova, A.	Cross-cultural differences for adaptive strategies of robots in public spaces [113]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	A social robot in an international event is used to investigate to whom the robots should adapt (children or adults) and whether culture influences this adaptation: results confirm differences between Kazakhstan and the USA.
2015	Andrist, S., Ziadee, M., Boukaram, H., Mutlu, B., Sakr, M.	Effects of Culture on the Credibility of Robot Speech: A Comparison between English and Arabic [114]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	The effects of language and cultural context on robot credibility are here explored. The rhetorical dimension of language improves the credibility of communication in Arabic rather than in English.
2014	Joosse, M.P., Poppe, R.W., Lohse, M., Evers, V.	Cultural differences in how an engagement-seeking robot should approach a group of people [115]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Cultural rules that hold in human interactions also apply to HRI, in relation to social distancing.
2013	Eresha, G., Haring, M., Endrass, B., Andre, E., Obaid, M.	Investigating the influence of culture on proxemic behaviors for humanoid robots [116]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Robots elicit the same rules of proxemic expected between humans - those deployed by cultures.
2013	Trovato, G., Zecca, M., Sessa, S., Jamone, L., Ham, J., Hashimoto, K., Takanishi, A.	Towards culture-specific robot customisation: A study on greeting interaction with Egyptians [117]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Egyptians preferred the Arabic version of the robot, capable of greeting and speaking in a manner aligned with their own culture, while they reported discomfort when interacting with the Japanese style's robot.
2010	Wang, L., Rau, P.-L.P., Evers, V., Robinson, B.K., Hinds, P.	When in Rome: The role of culture and context in adherence to robot recommendations [118]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Robots with a communication style aligned with that of the users' culture are usually better perceived. Cultures with high or low context may lead to different perceptions.
2009	Rau, P.L.P., Li, Y., Li, D.	Effects of communication style and culture on ability to accept recommendations from robots [119]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Chinese participants prefer an implicit communication style and perceive robots as more likable. German participants prefer explicit recommendations.
2008	Lin, W., Rau, P.-L.P., Evers, V., Robinson, B., Hinds, P.	Responsiveness to robots: Effects of ingroup orientation and communication style on HRI in China [120]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	Westerners prefer more direct forms of communication, while Easterners prefer an indirect communication style.
2008	Evers, V., Maldonado, H.C., Brodecki, T.L., Hinds, P.J.	Relational vs. group self-construal: Untangling the role of national culture in HRI [121]	Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities	US participants reported higher trust. Chinese participants were more comfortable than the US ones when robots and humans were perceived as in-group members. Chinese users were more likely to anthropomorphize the robot.

3.1 Influence of the Animistic and Religious Background in Human-Robot Interaction

In this section, we provide an overview of the documents that have tried to motivate differences in users' perception and interaction with social robots based on people's religious and animistic tendencies.

In the work presented in [97], researchers focused on the ways of representing the relationship with robots in Japan and the West. Specifically, they tried to evaluate the direction of the gaze of individuals portrayed in online images, in which human beings are involved in some relationship with robots, comparing them with the subjects drawn in a collection of ukiyo-e[2]. Here, usually, the mother and child share the gaze pointing towards a third element. This happens because children put themselves in the shoes of the adult, sharing the direction of looking, i.e., they have acquired the theory of mind, and a meaningful common world. In images with robots found using Japanese search keys, this same feature of *looking-together-versus* appears. In Western pictures (found using English keywords), this sharing of views on a third element is not present at all. According

[2] Ukiyo-e is a genre of Japanese art that literally translates as "pictures of the floating world".

to the researchers, this difference may be explained by considering that, in Japan, the machine is perceived as equal to the other subjects in the painting, able to share the sense and thus the mind of the humans involved, demonstrating a tendency towards anthropomorphism that is assumed to date back to Shinto animism.

Indeed, different studies refer precisely to this religious background. In [100], authors have explored how cultural, religious, and media differences influence the perception and interaction with robots, with a particular focus on the distinctions between Japan and Western cultures. In Japan, the animistic tradition seems to foster a greater openness towards humanoid robots, treated as entities with their own mind and spirit, in line with the Shintoist view that does not demonize anthropomorphism. In contrast, in Western cultures, where anthropocentric values and a more rigid view of idolatry prevail, there is greater resistance towards robots that imitate humanity. The concept of "mutual shaping" suggests that human and robotic cultures influence each other, giving rise to a dynamic process that leads to the emergence of a new form of shared culture. The concept of "cultural robotics" suggests that robots not only reflect the cultural values of their developers but can also influence and transform those values through embodied interactions. In [96], the religious background of participants was correlated with their moral care of robots: here, religion-related values, such as anthropocentrism and animism were found to better explain moral care for robots than religiosity itself. Indeed, moral care for robots had a negative association with anthropocentrism in the US, while, in Japan, it had a positive association with animism. The research conducted by Chikaraishi et al. [93] presents a different methodology: here, robotic behaviors were obtained from real actors and implemented in the humanoid robot, inviting the audience to report their impressions about the robots and their cultural and psychological background in a self-assessment questionnaire. The overall analysis indicated that the audience had positive feelings in terms of attractiveness. The only cultural difference recorded was the attribution of mental characteristics to the android by the Japanese audience, which was not found in the Italian, Austrian, German, and French audiences. In the former case, the robot is seen as a human-like entity, which, in the Japanese society, is an essential aspect to explain the full acceptance of humanoid robots. As anticipated, this factor seems related to the country's animistic tendency (ASA scores [122]) rather than empathy (which has been identified more as an individual psychological characteristic, i.e., no correlation has been found with the MES score [123]). Partially in contrast with these findings, the work of Trovato and Eyssel [112] investigates the attribution of mind to androids by comparing Italian and Japanese high school students' evaluations of an Asian-looking robot and a Western one. Researchers obtained the data through an initial test, collecting personal information on age, gender, current curriculum and familiarity with electronic devices, experience with robots in comics, films, and humanoid robots. Finally, they assessed individual differences in anthropomorphism by using the IDAQ questionnaire. The IDAQ scale consisted of nine items measuring the participants' degree of anthropomorphizing nature, the animal world, and technology, using three items per dimension (e.g. "Does the wind have intentions?", "Does the average reptile have a mind of its own?", "Does the average computer have a mind of its own?"). The results reveal that the Japanese users attribute the mind to a greater extent to the robot with Caucasian appeal. The explanation proposed here is that the mind is usually attributed to nature, which, like the Caucasian robot, is perceived as external to the group of individuals. The effect is indeed found in those Japanese subjects with more significant animist tendencies. However, for Italians with animist thinking, researchers did not find an identical outcome of attributing the mind to the Asian-looking robot. The study of Spatola et al. [99] showed that culture gives different meanings to what *prima facie* would appear to be the same concept. In this case, researchers demonstrated that a more or less anthropocentric background is strictly connected to how robots are perceived: greater anthropocentrism is connected to a higher humanization of robots; less human-centricity (as in Japan) leads to attributing minds but not human characters. A similar result was obtained in [95], relatively to the differences in robot's perception among Thais and international students: here, the prevalence of animism in Buddhist Thailand may have enhanced the belief that humanoid robots are social beings, that can be treated as moral agents.

Further, the research carried out by Castelo and Sarvary [98] shows that Americans are more comfortable with non-humanoid robots (such as Jibo and Kuri). In contrast, as the similarity to human beings increases (e.g., robot Nadine), the discomfort also increases. The study explains that the origin of the difference in perception between Japanese and American users is related to the animist heritage of the Asian archipelago, confirming that the Uncanny Valley is not just a Japanese phenomenon, as claimed in the paper of Kamide and Arai [94] - which we will discuss in the following sections. Concerning the work of Kim et al. [92], researchers assessed the possibility of robots being moral counsellors, examining the communicative strategies of different ethical frameworks (deontological, virtue ethics, Confucianism) for various groups. Initial evidence shows that robots with deontological rather than virtue-based and Confucian approaches are more persuasive. Yet, the robot is almost always a weak advisor to prevent dishonest actions, perhaps because its authority is not recognized. Interestingly, however, the robot's influence to avoid fraudulent acts is even weaker for individualistic countries. The explanation given is attributable to a greater level of competition that exists in individualist countries.

3.2 Influence of National Technological History in Human-Robot Interaction

This section deals with papers that have focused on how cultural familiarity with technology may have an impact on human-robot interaction. As an example, the work performed in [83] explores the relationship between media representations of emotions and artificial faces, critiquing the idea that emotions can be universally represented. The author emphasizes the importance of a contextualized approach, recognizing the influence of socio-cultural conventions, using examples from the Japanese Noh theatre to highlight how emotions are conveyed through performative conventions. Similar conclusions may be drawn from the work of Korn et al. [87], a survey including participants from Germany and Arab countries in which attitudes towards the roles, skills, appearance, emotional awareness, interactivity, and automation of social robots are examined. Researchers found that preferences differed not only between cultures but also within countries with similar cultural backgrounds, being Egypt, in particular, closer to Germany than to other Arab countries, perhaps because Internet has long been widespread in the African state earlier than in other Arab states. Generally, participants with an Arab background showed a greater preference for social robots with a human-like appearance and were more willing to accept highly specialized roles for robots (e.g. surgeons, pilots); indeed, Islamic culture firmly separates roles. As an example, they have shown preferences for social and medical assistance robots. On the other hand, participants with a German background considered industrial settings more appropriate for robots. In this regard, it is argued that, since Germany is among the top countries in terms of the spread of industrial robots, people confirm their national affiliation through their preference for robots in Industry, also reflecting a habit of seeing robots in those contexts. The results are also influenced by the gender of the participants, equally across cultures, but not by their economic status. In short, in addition to tradition, what may affect attitude towards innovation and robotics is the role of the narrative that passes through the channels of mass media and the Internet: Egypt, unlike the other countries that share the Islamic tradition, is similar to Germany in having a much more advanced degree of technological development, with an influence of Internet that is closer to the European state.

Yam et al. [85] underline how the cultural representation of technology may strongly influence people's judgment and preferences. In this sense, while Japanese mass media have heavily promoted robot and automation acceptance, media representations of technology in the West tend to be much more mixed, with the depiction of possible threats and negative effects of technology. In line with these findings, Turja and Oksanen [89] have investigated how the acceptance of robots at work depends on European individual and national characteristics. The influence is attributable as much to the role of the media and the spread of technology as to cultural tradition. Generally, the attitude of countries with both high and low technology diffusion was positive: the reason in both cases is that the fear of being replaced at work by a robot was not really felt by participants (either because there was actually no danger of robots being introduced in the short term or because robots were already present at work). Different conclusions for the same countries are attributed instead to media discourses that spread more or less optimistic attitudes depending on the period.

Another example illustrating the national differences in the apocalyptic perception of technologies may be found in [84], which analyses the impact of gender, age, and cultural differences on future perceptions of AI, using a sample of 530 adults from the UK and the US. The results show that American participants have a more positive view, harboring more hope for AI compared to British participants, with women, in particular, advocating this to differences in the educational system, media representations of AI, and internal policies. Educational policies have also been the focus of [88], which examines the differences between robotics students from different cultures. Conducted on engineering students from Heriot-Watt University in the UK and Xidian University in China, the study has found that Chinese students show more interest in social robots than British students, with a preference for robots that have a human-like appearance and a specific role, such as social assistants or healthcare providers. These preferences, linked to cultural traditions and media, suggest that the design of social robots should consider cultural differences and media representation choices to better meet the needs of users from diverse backgrounds, shaping design orientations accordingly.

Bartneck et al. [91] again investigate the influence of culture through the Negative Attitude toward Robots Scale (NARS). The States' cultural background and technological history had a significant impact here. For example, Japanese participants were not as positive as other studies have recorded: the reason was that they were aware of the social effects of robots. In this case, the technological history of the country led the Asian participants to evaluate robots negatively. This result contrasts with the results of [90], which will be better described in the next sections. Concerning other countries, US participants had the most positive attitude, while participants from Mexico had the most negative attitude. North Americans are familiar with technology, which can explain their positive attitude; at the same time, they are accommodating when talking to new people, a characteristic they also reflect in robots. The results related to Mexico need further clarification because the sample might have been too small. Finally, participants recruited from the online Aibo community were more positive towards robots than those not involved in such interest groups: so previous experiences with a robot had a positive effect. However, physically owning an Aibo did not change the attitude of the users. Another example in which infrastructural aspects, national laws, and, of course, implicit cultural norms influence the perception and interaction with robots is offered by [86]. Even if not explicitly dealing with social robotics, this work proposes an interesting socio-ecological perspective, emphasizing the importance of considering the larger context in which these interactions take place. It suggests the presence of a macrosystem, which includes factors such as cultural norms, national infrastructures, and traffic laws, significantly different from country to country and that can profoundly influence interaction. The paper also highlights a gap in research, pointing out the lack of consideration for cultural and regional differences in regulations and driving behaviors, including references to vulnerable individuals with disabilities. In short, it is clear from these latest studies how national and group factors intervene. Some characteristics are not purely cultural but national and diachronic, related mainly to the narratives of the media and communities in which one takes part, such as to construct a national, group identity or a perceptive habit to which one conforms when questioned in this sense.

3.3 Implementation Aspects

In this section, we have rounded up those papers that are more implementation-oriented, where culture is assessed in its practical effectiveness, through design or algorithms capable of recognizing, adapting to and imitating the culture of the subjects. In particular, a large pool of studies shows how to concretely design robots capable of expressing (verbal and non-verbal) culture-sensitive behaviors and adapting to new scenarios. Tuyen et al. [75] propose an incremental learning model for the selection of the user's habitual emotional behavior, emphasizing the cultural traits of individuals identified through long-term interaction. Specifically, the various similar actions are gathered into a single cluster, representing the appropriate behavior: the cluster gathers habitual actions, which are ultimately those assumed to be influenced by a common cultural background. The proposed transformation model converts the users' emotional behavior into the robot's movement space (Pepper, in this case). The results confirmed that this approach allows a social robot to learn emotional behavior from individual users: it is a promising method for teaching new gestures to the robot by demonstration rather than through offline (rule-based) programming, as commonly done. Furthermore, researchers have verified that these kinds of robotic movements are judged emotionally acceptable by the demonstrators (i.e. humans that initially show the robot movements it has to learn and then execute) and recognizable by subjects of the same cultural background. The results confirms that the cluster of actions translated into the robot's movement effectively represents a pattern of gestures influenced by culture.

Similarly, Le Quyen Dang et al. [29] discuss a model for the representation of emotions in social robots. The proposal is based on the role of internal and external emotional signals from human guidance and the robot's experience. Engineers designed a long-term memory architecture to enable robots to acquire knowledge and obtain new emotional information during the interaction. In particular, in this work, robots can extract specific properties from visual stimuli, which are used to form an affective evaluation of objects and to recall past experiences when needed. Regarding the role of culture, the initially neutral robot is made to interact with a group of human beings sharing the same cultural background, with the aim of learning the emotional behaviors of the culture it has been immersed in. However, when the robot has to adapt to an individual who is not familiar with the culture it has been trained in, it uses its previous experiences and clues to interpret and respond to the new stimuli, to which it is thus able to adapt.

In addition to providing a precise definition of cultural competence in robotics and proposing a concrete development and evaluation methodology for this skill, Bruno et al. [51] analyze the capabilities required to enable the robot to behave in a way that is culturally competent (and adaptive). Cultural competence unfolds in awareness, knowledge, and sensitivity: the representation starts with pre-understandings, i.e. *educated guesses*, provided by experts, which are used to speed up the adaptation of the system to the user. The model allows therefore the machine to autonomously acquire further information and update its knowledge, reconfiguring its approach towards the user. The culturally competent framework for social robots has been practically carried out within the project CARESSES, also demonstrating its feasibility as a Cloud system [72], i.e., a set of robotic services that equip robots with cultural competence in verbal interaction.

In [30], the focus moves to a culture-dependent greeting selection system. Researchers trained the robot using data deriving from studies in sociology in a country-dependent, rule-based manner. However, thanks to the implemented model and feedback from the subjects it interacts with, the

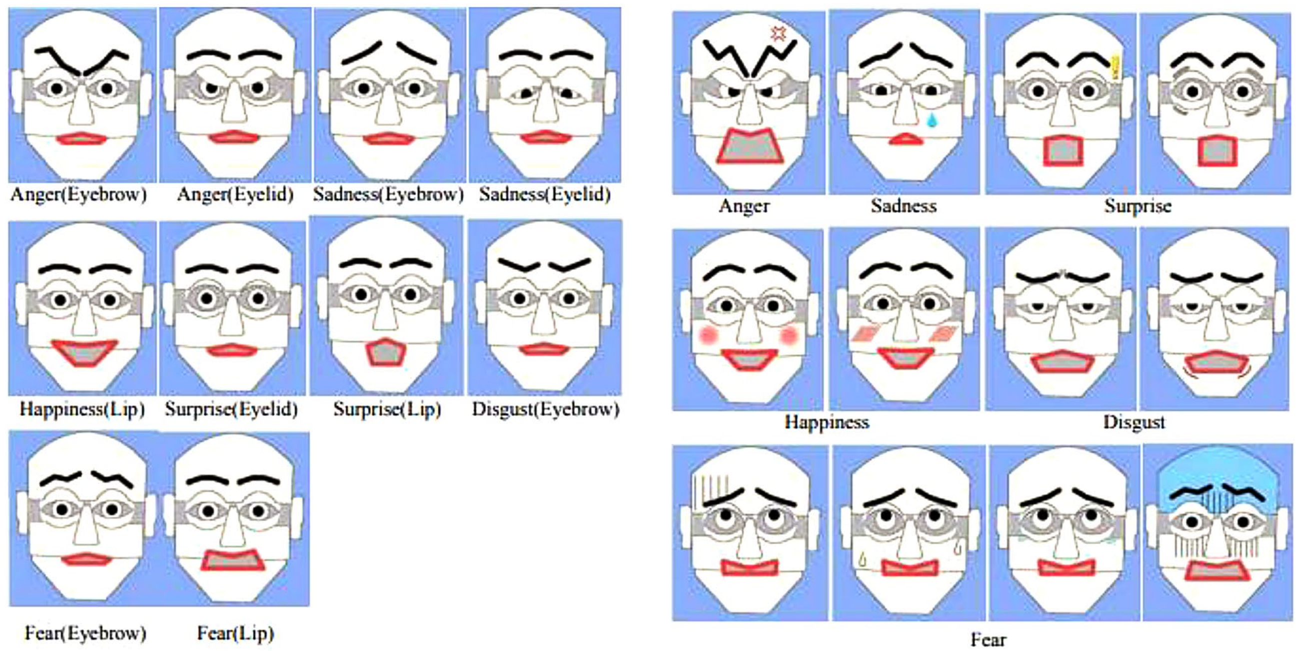

Fig. 3 KOBIAN-R's facial expression, with and without cartoonish cues

system can evolve its behavior in a certain number of interactions, adapting to new individuals and new cultures.

Generally speaking, many research works have implemented systems for the robot to exhibit emotions and ways to facilitate their recognition. In [80], a robot model can flexibly change its facial configuration, adapting to different cultural backgrounds. A generation system producing facial expressions was realized and applied to the head of the humanoid social robot KOBIAN-R. Thanks to the work of illustrators and cartoonists (Fig. 3), the system can generate two versions of the same expression so that both Japanese and Western subjects can easily recognize it.

Experimenters introduced here Manga-style symbols as a tool to facilitate emotion recognition for some cultures. They extended the investigation also to Egyptian subjects as a representative sample of another culture. When dealing with basic emotions, recognition posed no problems; on the contrary, culture impacted the judgment of facial cues during more complex situations. A robotic head that shows an expressive capacity through the emotional clues typical of Japanese cartoons has also been presented in [31]. An average recognition rate of over 90% for the six basic emotions is also confirmed here. In contrast, recognition rates in Germany for complex and context-dependent emotions such as 'disgust' and 'surprise' are significantly lower than in Japan. On the other hand, the emotion 'fear' achieved a higher recognition value in Germany than in Japan. Comics are, in fact, cultural objects, so their code only takes meaning in the perception of the groups for whom that sign has value.

Similar insights related to emotion recognition through facial expressions have been demonstrated in [82], where Japanese users were found to have issues in recognizing surprise, fear, anger, and sadness. Indeed, also in this case, the problem emerges for more complex emotional states, since only the body's clues are not sufficient for a correct interpretation. Exploiting context can relieve researchers of the need to create highly specific models, helping humans to disambiguate the mimicry assumed by the robot. Still focused on the generation of emotions for culturally competent social robots [76], explores intercultural variations in facial expressions of emotions, highlighting both similarities and differences. While emotions such as happiness, sadness, and surprise are generally recognized similarly worldwide, more complex emotions like fear, disgust, and anger vary significantly depending on the cultural context. Using traditional methods and data-driven approaches, the study shows how dynamic factors such as the amplitude and latency of facial movements influence the interpretation of emotions. The results emphasize the importance of intercultural understanding to enhance social communication, with significant applications in social robotics, where awareness of cultural differences in facial expressions can improve human-robot interaction.

To confirm this assumption, Bennett et al. [79] have evaluated the congruence of context on human perceptions of robotic facial expressions between individuals in West and East Asia. The results showed that context concordance significantly affects the perception of robotic expressions. Another example of a model capable of adapting based on context, enabling flexibility and personalization, is discussed in [71]. Here, a Python library, CoBaIR, is proposed for intent recognition in human-robot interaction (HRI) contexts. It uses a two-layer Bayesian network that is data-driven, and when data is unavailable, it functions as an expert system. CoBaIR is designed to address cultural diversity, adapting to various environments and enhancing the understanding of human intentions. Additionally, due to its ability to adapt and learn from data, it is a scalable solution, improving the naturalness and effectiveness of interactions between humans and robots, with a focus on cultural sensitivity and reliability.

With regard to gait, Izui et al. [78] show that it is possible to convey emotions through gait pace and that there is a difference between France and Japan in the prediction of emotions. Neutrality, sadness, and anger were easily identified for both groups, while fear was mistaken for sadness and joy for fear by French participants.

Culturally-competent human gestures were also considered to improve human-robot interaction [81]. Here, a methodology using RGB-D cameras and spiking neural networks was proposed to recognize gestures and handle cultural differences in communication. Conversely [77], used a Bayesian network to model culture-dependent non-verbal behaviors, trained on a video corpus of first-meeting scenarios between German and Japanese participants. The model demonstrated its ability to generate culture-specific non-verbal behaviors, including differences in gestural expressiveness and posture, confirming its effectiveness in simulating culturally nuanced interactions. The network, which considers cultural background and verbal behavior, showed a strong correlation between cultural background and posture, with significant differences between the cultures. Gestural expressiveness revealed marked differences, suggesting that the model can support the cultural adaptation of non-verbal behaviors. However, reliable predictions regarding gesture types were not made, likely due to the abstraction of gestures into general categories that failed to capture concrete cultural differences. Still regarding gestures [124], proposes a data-driven approach that aims to generate culturally sensitive gestures that are coherent with the expectations of people self-identifying with a given culture. Previous methods have mainly used rule-based approaches, in which the rules for mapping speech to gestures are handcrafted, or data-driven approaches that do not take into account cultural differences. The paper has shown promise in embedding cultural characteristics into the generated gestures, as evidenced by the positive feedback from participants identifying with different cultures. Another example of a deep learning-based model is the one proposed in [73], which introduces an innovative approach for analyzing engagement in children with autism during robot-assisted therapy sessions, with the CultureNet model. This model utilizes multicultural data, collected from 30 children from Asia and Europe, to estimate the intensity of active participation through video analysis. Compared to generic models like GenNet, CultureNet stands out for its ability to adapt both to the target child and cultural specificities, showing better performance in both intra- and inter-cultural assessments. The study highlights how integrating cultural data is crucial for improving the accuracy of estimates, contributing to personalizing robot-assisted therapies based on cultural and individual differences.

A review effort [105] shows how personalization and localization in robotics must go beyond the satisfaction of simple language preferences or accents. The results confirm the importance of robot localization, to model proxemics and implement expressions to improve human acceptance during human-robot interaction.

Generally speaking, the complexity of the cultural analysis suggests that rather than designing an algorithm to determine the correct interaction for each cultural group, it may be more appropriate to develop a classification map that tracks similarities between different cultural backgrounds. Finally, it is worth mentioning here the work performed in [74], which presents a specific case study on design and how it can influence gender interpretation. Here, although cultural differences can influence various aspects of human perceptions, the perception of robot gender based on body proportions such as the CHR (Chest-to-Hip Ratio) and WHR (Waist-to-Hip Ratio) is not significantly influenced by the cultural background of users. Participants from different cultural backgrounds, such as Peru and Japan, showed similar patterns in attributing gender to robots based on these proportions. This suggests that the perception of robot gender, influenced by physical characteristics such as CHR and WHR, is a universal phenomenon that transcends cultural differences. This finding is significant, as will be explained further in the results and conclusion.

3.4 Perception of Robots with Verbal and Non-Verbal Culture-Aware Communication Capabilities

This section focusses on papers that examine how robots equipped with culture-aware algorithms in verbal and non-verbal communication, and language pragmatics rules may have impacts on HRI. Pragmatics deals with the use of signs, their effect on speakers, and the meaning that linguistic strings take on depending on the context. The *unspoken,* i.e., implicit and explicit rules, prior and shared knowledge, presuppositions and implicatures, and speakers' intentions, are all relevant in this context. For example, rules of politeness are one of the most relevant socio-pragmatic phenomena.

Studies in this context show how the dynamics that apply to humans can be found in the interaction with robots and implementing them in HRI leads to greater acceptability of the robot. In [103], cultural differences related to expressions of politeness (indirect speech, honorifics) usually adopted in linguistics have been applied to HRI. When the context becomes conventional, the preference for indirect speech increases in English, while the use of honorifics increases in Korean. On the same pattern, Kumar et al. [104] found differences between Israelis and Arabs in the preferences and perception of errors during the interaction with a polite and an unpolite robot. The Korean culture has been taken as a reference also in [102], where experiments were performed with a bilingual avatar (Korean and English speaking). The avatar however was speaking and behaving in an identical way in both languages, without a cultural adaption. The results here indicate that cultural differences between the two countries, in particular, related to the communication styles, impacted the perception of the avatar, which received more positive feedback, in terms of perceptions, animacy, and likeability, by English speakers.

In addition to what has been already mentioned, pragmatics studies force, authority, and the conditions under which an exhortative elocutionary act takes effect [125]. The already mentioned work of Kim et al. [92], who propose a robot capable of persuasion/dissuasion based on different ethical frameworks, is in line with other studies [108], which show that users accept Nao's robotic recommendations more easily if the behavior is designed with cultural differences (language but also culturally competent greeting gestures) in mind. In particular, through a Wizard-of-Oz method, investigators remotely controlled the type of response Nao would give to the subject, in terms of gestures, language, or greetings designed to be culturally competent. Acceptance was measured through a questionnaire, and the results confirmed that perceived trust increased with the culturally competent robot. These findings further confirm the results highlighted in [117], which show how Egyptian users seemed to prefer the Arabic version of the robot, capable of greeting and speaking in a manner aligned with their own culture, while they reported discomfort when interacting with the Japanese robot. Cultural differences, and their influence in the perception of positive and negative feedback (agreement or criticism) in Denmark, Germany, and Poland were also the object of [107]. The study incorporated expressions of encouragement or criticism adapted to the preferences and communication styles of each cultural context. These styles were previously identified in a preliminary qualitative study where participants had provided feedback on entrepreneurial ideas, and then integrated into the dialogues of the robot to test cross-cultural perception of feedback. After receiving feedback, participants evaluated the robot based on characteristics such as motivation, friendliness, and empathy. The results highlighted significant differences in feedback evaluation: Danes found the positive feedback less motivating and empathetic than Germans, while Poles appreciated the positive feedback more. This suggests that robots providing feedback should take into account the cultural background of users, and that using robots to study intercultural communication is a promising methodology for exploring pragmatic differences in a controlled setting.

The importance of adapting robot backchanneling strategies for different socio-cultural groups to promote participation and a positive perception has been discussed in [101]. Backchanneling, studied in pragmatics, i.e., the branch of linguistics that examines the use of language, refers to brief, non-verbal responses (e.g., "hmm") or verbal expressions (e.g., "yes", "I understand") used to signal attention, understanding, or encouragement during conversational turns without interrupting the flow. These responses do not add new information but serve to maintain conversation flow, confirm attention, and encourage the speaker to continue. The study examines how different groups may respond differently to attention and understanding cues provided by robots, depending on their cultural and social norms. The study emphasizes the importance of adapting backchannel strategies for the members of the same culture, implementing them in social robots designed to interact with various socio-cultural groups to encourage participation and improve the perception of these technologies.

By focusing again on credibility, the work presented by Andrist et al. [114] explores the effects of language and cultural context on robot credibility between participants from Lebanon and the USA. Lego EV3 robots were assembled to represent humanoid design, with gender-neutral names and voices, and finally designed to be tour guides of environments shown on a screen. Different levels of perceived credibility were measured subjectively (via questionnaire) and objectively (by observing acceptance of robot suggestions). The results confirm that the rhetorical dimension of language improves the credibility of communication in Arabic rather than in English. Furthermore, communication was more effective when the robot communicated in a local Lebanese dialect, rather than in modern Arabic. The reason underlying the Arabs' preference for *less direct* language has been correlated to the classification proposed by Hall [126], who introduced the idea of low and high-context cultures, where 'low context' refers to cultures where communications are explicit and require little interpretation to understand the content. Based on this classification, Arabs prefer more rhetoric and implicatures than English because they belong to a high-context culture.

Many other research works are based on the Hall classification, since they include low or high-context cultures among the variables examined [118–120]. Ample evidence in intercultural psychology and communication suggests that Westerners prefer more direct forms of communication, while Easterners prefer an indirect communication style. On the other hand, high-context cultures are those in which content is less central, and deciphering contextual signals is necessary for accurate decoding. In particular, those research works assess whether explicit or implicit communication styles and spoken language affect the acceptance of robotic recommendations. The results again confirm a preference for robots with a communication style aligned with that of their own culture, whose recommendations are more readily accepted. Particularly in [120], Chinese people were more likely to see robots as part of the group, but this did not affect the acceptance of robot recommendations. On the contrary, they were more inclined to change a decision based on the robot's advice when the robot communicated implicitly. For high-context cultures, insights from research works suggest how designers should strengthen the robot's non-verbal communication skills in order to let the robot be a credible source of information. In any case, all these results confirm the importance of culture-specific personalization, both in greeting and conversation, for positive human-robot interaction.

Other works, such as the one of Lugrin et al. [109], are mainly based on the individualism-collectivism dichotomy, which, in this case, is analyzed in a conversation task between a social robot and Japanese or German people, to assess the preference for one of the two behaviors (individualistic/collectivistic) implemented in the robot. The results show no significant differences between the two robot versions, but the reason for this could stem from the choice of the Japanese sample, who frequently visited Germany and were accustomed to Western culture (in fact, researchers recruited the participants from a German spring school). Participants from Germany, in any case, had a non-significant but higher average preference for individualistic behavior preferences. In contrast to these findings, a difference between individualistic and collectivistic cultures was found in [28], where participants were asked to play a ball-throwing game with other two players, represented by the avatars of another human being and the humanoid robot iCub. The more the participants displayed a collectivistic stance, the more they tended to pass the ball to the robot. Moreover, in collectivist cultures, the more an individual is perceived as autonomous and endowed with a 'mind of his own' [127], the less he is perceived as a member of the group. Hence, attributing intentionality to robots affects the social exclusion of the robotic agent, but only among members of a collectivist culture [112]. In other studies [120, 121], trust has been found as directly proportional to the in-group perception of the robot.

The robot's culturally competent non-verbal communication also affects its perception of pleasantness. Hence, a robot is supposed to follow the same rules usually followed by humans in daily interactions, in particular in terms of body language and proxemics. In the work of Shidujaman and Mi [111], participants from China, Thailand, Japan, and Bangladesh were asked whether the Nao robot performed a generic greeting gesture or a greeting gesture native to their own country. The results confirmed that users often correctly identified the origin of the gesture. Moreover, they perceived the native one as a more positive greeting. On the same line, Yu and Ngan [90] have examined different head tilts, with movements based on culture. Their work again shows that non-verbal signals such as head motions, commonly displayed in smiling behaviors, impact the robot's perception of warmth. In many of the papers, researchers have studied proxemics; in all of them [106, 110, 115, 116], as it happens for pragmatic theories, they have assessed how the same cultural social norms of social distancing that exist in relations between humans also apply in relations with robots. The only inconsistency concerns the evaluation of Argentinian users in [115]: indeed, Argentinian subjects were similar in their responses to the US participants, despite Argentina being a contact country such as China [26]. However, Hofstede's work can provide a possible explanation: Argentinians individualism score is closer to China than to the United States. However, if we look at other Latin American states, such as Ecuador, Venezuela, Colombia, and Chile, we may consider Argentina as an individualistic nation.

The fact that adherence to cultural-based proxemics helps improve robot liking and acceptance has also been shown in [113]. Here, the aim was to examine the adaptation of a robot in international events or spaces (e.g. airports), intending to investigate to whom the robots should adapt (children or adults) and whether culture influences this adaptation. There have been identified several significant differences between Kazakhstan and the United States: in particular, Kazakhs require the robot to understand kinship relationships, to adapt to either the child or the adult. The authors conclude that implementing proxemics rules needs to be coherent with the relationship/non-relationship status, however, taking in mind that those kinds of rules change from culture to culture.

3.5 Cultural Difference in Robot Trust and Preferences

In this section, the analysis focusses on studies that investigate how culture conditions attitudes towards robots (either "standard", or culturally competent) in terms of trust and general preferences (appearance, use, social skills). It may be helpful to start the discussion from more theoretical papers, such as [63], who investigates the concept of "trust" in robots, proposing ecological and phenomenological perspectives[3], as opposed to contractual approaches, which see trust as a contract between the parties, robots and humans, rationally calculated on efficiency expectations. The author emphasizes here that trust in robots is not simply a matter of control or rational calculation, but develops similarly to trust in human relationships, through situated interaction, where experience and cultural differences play a fundamental role. The author highlights how the criteria for evaluating trust - agency, appearance, social relations, and existence - are inevitably influenced by cultural differences, requiring a continuous process of interpretation that is sensitive to local specificities. This implies that, although it is possible to formulate general ethical guidelines, these cannot disregard an evolving cultural and social context, where appearance and robotic emotions require particular attention to avoid excessive expectations or misunderstandings in human-robot relationships.

In another study [68], the same author proposes a methodological approach that shifts from analyzing the robots themselves to analyzing human-robot interactions, emphasizing the importance of appearance, experience, and imagination. He adopts here an anthropocentric approach, analyzing how robots appear to humans and how these interactions influence social and emotional life. The appearance of robots is crucial in determining how humans interact with them, influencing behavior and perception, with significant implications for human well-being and individual flourishing. In this context, an ethics sensitive to cultural differences and individual experiences is necessary, considering concrete interaction and the imagination of people. Indeed, the work proposed in [16], already cited in the Introduction, presents a critical perspective on the danger of transforming the culture-aware robot into a projector of racism and prejudice. It is indeed a real risk, but, as mentioned, this risk may also be easily avoidable if cultural sensitivities are implemented with the possibility of correcting choices in a dynamic interaction, with robots able to learn during the interaction, as shown in our recent studies [9, 17, 18].

The work of Alemi and Abdollahi [43] explores, via the NARS questionnaire, Iranian and Chinese attitudes towards social robots. While there is no actual robot implementation, the differences identified in the survey performed by the authors are significant, although weak. In particular, Chinese people seem to have a slightly higher average acceptance than the Iranians, while gender and previous experience with robots have no impact. The study described in [44] investigates again how cultural differences can influence preferences. Here, an interactive online survey evaluates a hypothetical multi-robot system in robotic care homes, with China, India, and the USA being the nationalities examined. The results show that, if Indians seem to show clear differences in terms of preferences, US and Chinese participants' responses to the survey are similar, being, therefore, the 'East-West' classifications often simplistic. In this sense, the work performed by Dang and Liu [45] found a slight difference between China and the US regarding attitudes towards robots with high or low mental capabilities. Indeed, robots with high cognitive capabilities elicit more ambivalent attitudes in both groups, although among Americans to a greater extent.

A similar work [46] has been carried out to study the acceptance of human-robot collaboration in an industrial work environment, comparing attitudes in Germany, Japan, China, and the USA. These results also highlight that cross-cultural differences do not allow countries to be grouped into two 'East-West' macro-groups, but they require more deep analysis. Indeed, as already underlined in Sects. 3.1 and 3.2, differences in robot's perception seem to respond to possible causes such as the level of automation in the country, the spread and use of technology in everyday life, the addictive effects of robots, and data protection laws for the spread of video surveillance. However, in partial contrast to these findings [50], analyses the phenomenon of the Uncanny Valley for rural and urban Malaysians. Here, there is no evidence of a difference due to internet exposure: the Uncanny Valley occurs in a similar way among urban and rural dwellers. The only difference was that the rural respondents were more welcoming to strangers: when researchers showed them a picture of a Western model, they were not repulsive. Community spirit in rural areas is still high, which encourages acceptance and trust among villagers. Cultural differences and exposure to technology influence on the acceptance of robots, with a focus on the "Uncanny Valley" effect, were also the focus of [55], which describes the discomfort towards robots that appear almost human. The results indicate that the intensity and type of emotions (natural or exaggerated) affect the perception of robots. Japanese participants preferred robots with natural emotions, especially in social and caregiving contexts, in line with their culture that blends the natural and artificial. The French, on the other hand, did not show a strong preference, favoring robots in less emotional roles, such as in offices. Additionally, exposure to robots played an important role: those with more familiarity with robots perceived them as safer and more welcoming, while those with less familiarity

[3] Ecological perspectives focus on the interaction between individuals and their environment, emphasizing that objects, their shape, show their usability, known as affordances. This view aligns with the idea that the mind is not confined to the brain but extends into the world through interactions with it. Meanwhile, phenomenological perspectives highlight subjective experience and perception as central to understanding (and build) reality.

tended to be more skeptical. Culture, religion, and exposure intertwine, influencing the acceptance of robots.

Furthermore, several papers investigate the tendency to anthropomorphize robots. In [37], a robotic head was used to investigate joint attention in a mutual gaze task, by recruiting Singaporean and Italian participants. Here, Singaporean participants showed a higher tendency to engage in joint attention with an artificial agent, in comparison to Italian participants. This may confirm that East Asian cultures are more prone to treating the robot faces as social, and thereby are more likely than Europeans to adopt, with robots, socio-cognitive mechanisms that have been developed in interactions with humans. On this line, the work of Fraune et al. [41] describes a Participatory Design modality in which US and Japanese groups were asked to visualize a robot to combat loneliness in the elderly. The Western group saw the robot as a tool that would help the elderly in social relations, hence depicting telepresence robots and AI that would promote social skills. On the contrary, the Japanese group proposed companion robots, hence a robot that would act as an autonomous entity and relate with humans. The difference can again be explained by referring to the animistic background of Japanese people, as mentioned in Sect. 3.1. The work of Evers et al. [121] further confirms that Chinese persons are more inclined to anthropomorphize the robot than Americans.

However, an additional experiment conducted in [40] reveals how the association between lonely people and the tendency to perceive robots as anthropomorphic and choose robots with humanoid traits was higher in US participants than in China. The reason for this tendency may be due to the idea that robots in animistic countries like China can be a means for exploring the social world, but for lonely people who do not want to connect with people, avoid relationships also with robots, perceiving those technologies as a substitute to humans, more than US people. For Western people, anthropomorphism is design, not real relationships, but something that can empty the needs of others with no deep implications like it was if there was a real rapport.

In [49], researchers evaluated how the background of Japanese and German people affects the perception of two domestic social robots. One of the robots had a rather technical appearance, while the other one had a more advanced head. Participants from both cultures have however evaluated both types of robots similarly. Unexpectedly, Japanese participants, although generally showing a tendency to anthropomorphize non-human agents, judged both robots less human-like than German participants, confirming that anthropomorphism and mentalization are two separate categories. Here, the lower tendency of Japanese people, also shown by Bartneck [69], to accept robots and trust them is confirmed. The same result emerged in [94], in which researchers used storytelling to manipulate the robot's characteristics and make it more or less anthropomorphic. The results showed that Americans perceived the robot as more comfortable, controllable and performant than Japanese respondents, who showed comfort when the number of anthropomorphic features was limited. Overall, US participants liked robots on average more than Japanese participants. These results, however, seem to be contradicted by many other studies where the Japanese culture seems to have more positive attitudes towards robots [52, 54, 58]. Furthermore, some works [69] describe Americans as immune to the Uncanny Valley, since it strictly appears to be a Japanese phenomenon. However, as seen above in other research work [50], the Uncanny Valley also seems to occur in Malaysia, and among participants who are not overexposed to the Internet. At a glance, if it may seem challenging to draw unequivocal conclusions that link the concepts of anthropomorphism and mentalization to the acceptance of social robots, it is somehow evident how the appearance and capabilities of robots impact these aspects, ultimately influencing, in a culture-dependent way, the pleasantness of the interaction.

Regarding affective design, it is interesting to mention here an educational project that explored the Japanese concept of "kawaii" (cuteness) in the design and perception of robots, involving Japanese and American students in a remote collaboration during the COVID-19 pandemic [33]. Through the creation of virtual spaces and pairs of robots, students analyzed how specific design choices could express affective cultural values, using assessment tools to measure the impact of their creations. The study highlighted "kawaii" as a central cultural value in Japanese culture, while also demonstrating that individuals from other cultures can understand and appreciate its meaning, promoting intercultural dialogue in design and fostering technological acceptance. In another work of Fraune et al. [58], Japanese and US participants preferred interacting with robots in groups, and rated social robots as friendlier and more helpful than product-like robots. In this regard, the work of Giuliani et al. [62] also examined whether a 'bartender robot' should exhibit social behavior when interacting with German and English users in an activity-based context or whether it would be better for the robot to complete only the required task (i.e., filling glasses). In both cases, a longer interaction characterized by a specific social behavior was rated more positively, demonstrating that the socially intelligent robot was always the most valued. The only cultural difference found was related to the pre-test evaluations: German participants gave significantly lower scores on the Godspeed pre-test, whereas their post-test scores were similar to those of the English participants.

Several papers deal with the preferred application areas of robots, i.e., the scenarios in which participants would place a robot. In [61] researchers found that US participants were not willing to use robots in everyday spaces but they identified factories and hazardous environments as appropriate contexts for their use, i.e. functional robots. On the contrary, while Americans see robots as tools, Koreans believe that robots should have social roles. While these findings seem to contradict the aforementioned studies [58, 62], it should be noted that, in those studies, participants' preferences were not asked in an extensive sense, but they were directly introduced to a robot in the cafeteria [58] or a cafe [113], leading them to evaluate social robots in these specific spaces. In this sense, a controversial topic of use was addressed in [32]. Here, through an online survey, the study investigated how people from different cultures, specifically Japanese and American, accept the use of robots in self-defense (RSD). The study explored perceptions of robots in this context both theoretically, through a rapid literature review, and from the perspective of public opinion. The results showed a general acceptance of RSD, while highlighting some cultural differences: Japanese participants were more cautious compared to their American counterparts. These findings emphasize the need to consider the cultural context in the design and implementation of robots in sensitive areas such as law enforcement and the military, also due to subtle ethical and legal implications.

Variables related to social hierarchy and etiquette (e.g. bowing, use of honors) also assume relevance here [103, 104], especially for Korean and Turkish cultures. Here, Korean participants' preference for honorifics with respect to indirect speech acts may indicate that, in this context, it would be desirable for robots to use honorifics as well. Moreover, Turkish and Korean participants' preferences for specific robot roles reflect local social dynamics. The extended family structure in Turkey, where grandparents participate in the family's daily life, made them essential potential users. Also, both in Turkish and Korean societies, women are the predominant users in household settings, mirroring the gender-based division of domestic responsibilities within those societies.

Americans attributed "no emotion" to robots, being more inclined to regard them as interesting scientific and technological products [70], while Japanese and Korean potential users see them as communication partners in domestic and work environments. Koreans were more likely to accept them in hospitals to deal with life-and-death situations, while Japanese foresee their usage in nursing and educational activities. An opposite result however was found in [39], when analyzing the interaction of USA and Korean users with a pet robot: here Koreans were found to treat the robot as a technological instrument, probably because they have a significantly lower degree of familiarity with pet animals, while USA perceived the robot as an interaction partner, almost a substitute for pets. Also, in [57], a comparison is made between human-like and product-like robots, studying the cultural differences between Korea and Japan. Firstly, Japanese persons seem to be more inclined to attribute thought and action to a humanoid robot, while Koreans view the product-like robot more positively; however, no differences were found between both cultures on purchase intentions. Similarly, the work performed in [56] also shows that differences in human-robot trust do not lead to a different willingness to use the robot. Moreover, according to Hofstede, long-term oriented cultures (e.g., China) may be more prone to accept human-like robots than short-term oriented ones (e.g. USA) [38], since they are more likely to accept societal changes.

On a similar topic, Rau et al. [67] investigate the effects of culture (Chinese, Korean, and German), robot appearance (anthropomorphic, zoomorphic, and machine-like), and task (teaching, driving, entertainment, and security guard) on human-robot interaction. As in Hofstede's theories, here collectivist cultures (China and Korea) have been found to be more likely influenced by people communicating with them, tending to be open to accepting others' suggestions. This finding could be correlated with a greater interaction involvement and trust in the robot. Also, participants from feminine cultures, i.e., Chinese and Koreans, showed greater liking and satisfaction with the small and slow social robot used in the experiment, while individualism may have induced German participants to prefer more sense of control and to see robots as tools or machines, rather than as companions or personal assistants. Overall, compared to the German participants, Chinese and Korean participants perceived the social robots used in the experiment as more sympathetic, reliable, satisfying, and engaged. The results in this study indicate that when a robot is designed to be multifunctional (e.g., able to operate in different contexts, as a teacher, entertainer, or security guard), users from low-context cultures, such as Germany, feel a reduced involvement during tasks where less interaction is expected, such as when the robot is operating as a security guard. Similarly, differences between cultures in terms of avoiding uncertainty have been explored in [34], where fast food employees identifying themselves as belonging to a high uncertainty avoidance culture (i.e., Egypt) have been found to have more difficulties than people identifying themselves with a low uncertainty avoidance culture (i.e., Malaysia) in adopting robotics technology, because they experience difficulty using, learning, and adopting new technology. In [36] the focus was shifted to the analysis of human-robot gender congruity, showing that also in this case there is a cultural component: users high on masculinity can feel a higher perceived control in the case of human-robot gender congruity. Similarly [35], has analyzed cultural differences in a specific work context, i.e., in the training needs of healthcare professionals for the use of social assistive robots. The results show that in collectivist countries, there is a greater emphasis on understanding the capabilities of robots, while in individualistic countries, the focus is more on the tasks that robots can perform. Moreover, in contexts with high uncertainty avoidance, more attention was given to the safety and control of robots.

On a different line, the work of Rudovic et al. [53] focuses on care robots for children with Autism Spectrum Disorder (ASD). Researchers investigated here the impact of cultural influence (Japan and Serbia) on capturing attention and interest towards robots and social tasks, maintaining prolonged therapy sessions with children aged 3 to 13 years old. Here, differences were found in relation to the different age ranges examined, but researchers avoided causal explanations due to the limited time of the experiment (one day). In any case, cultural data seem to play a relevant role in this context, as already discussed for deep learning models aimed at capturing engagement levels in children with ASD [73]

Still about care robots, a short- and long-term evaluation of a small humanoid for social care robot in an intelligent home environment in Austria and Israel has been carried out in [59]. The results showed that participants of both countries equally trusted the small humanoid robot, while enjoyment decreased over time in both cases. However, the study can have some biases, which will be discussed in Sect. 4.

In [60] as well as in [66], researchers have investigated how children from two different cultural backgrounds (Pakistan, Netherlands) and two different age groups (8 and 12 years) experience their interaction with a social robot (iCat) during a collaborative game. The interaction with the robot was highly appreciated by the children, although Pakistani and younger children enjoyed the task more than Dutch kids. Moreover, Pakistani children hugged and touched the iCat more often than their Dutch counterparts, who hardly touched the iCat and rarely touched their friends. Interestingly, the Pakistani children showed some culture-specific gestures, e.g. they often made a ‘prayer gesture’ when they were unsure of the answer or when iCat gave an ambiguous answer. During the interviews, at least three children mentioned iCat’s ‘inability’ to pray and found it rather ‘strange’.

This study could also have been included in the section on religious influence; however, we chose to include it here to also highlight the lack of religious influence on trust. This illustrates what was mentioned at the beginning: cultural categories are fluid and depend on how relevant a sense of belonging is for a group in shaping personal identity. The same applies to the studies by Mavridis et al. [64], in which the most significant results concern religion, but the focus also included dynamics such as age, education, and gender, which led us to place it in this section. The religious influence of Islam has a strong impact on personal identity and perceptions, creating a more cohesive group compared to others. This is consistent with what Lalumera [7] observes regarding linguistic and cultural relativity: she notes that explicit tasks and linguistic prompts can make cultural influences more evident in individuals’ responses, confirming that culture mediates perception and action in a context-dependent way.

Mavridis et al. [64] studied the attitudes towards robots in the Middle East. In this work, Ibn Sina, an android robot deriving from Islamic history and capable of conversing in Arabic, was brought to Dubai, in one of the most important exhibitions in the region, involving in the experiment a vast number of participants from different countries. The experiment revealed that the South-East Asian group was the most favorable for the use of the robot in healthcare settings. On the contrary, respondents from Europe and the US provided the lowest scores among all groups in their feedback. Here religion seems to have a statistically significant effect: indeed, Hindus, Buddhists, and Taoists seem to have the most positive attitude toward the usage of robots in hospitals and schools, while Muslim and Christian respondents are indifferent and negative, respectively. Muslims however positively consider a possible usage of the social robot in school, perhaps because the robot in the survey is modelled on a historical character of Islam. Unexpectedly, a gender bias was found: women were more positive in the study than men, probably because the robot has a masculine appearance. In contrast, the language of the survey does not seem to have any statistically significant effect on the responses. Similarly, in [65], a series of experiments have been carried out to assess the amount of collaboration between human and robot users in a cross-cultural context, showing that the robot’s appearance and functions affect the attribution of personological traits to that robot. In particular, participants judged the robot CEO and the robot teacher as more extroverted, because their role requires them to have these personality features, than the robot pharmacist, who was evaluated as introverted.

Generally we have seen that culture has got almost always an impact. In [47], it was found that culture does not exert any influence on the choice of gesture type, except for gestures with a strong cultural reference, such as those related to music. In this context, Vannucci et al. [48] have conducted experimental studies in Japan and Italy, to investigate the speed of adaptation of Japanese and Italians when imitating a robot during a collaborative task involving LEGO blocks. Cultural differences again did not affect the subjects’ common predisposition to adapt to the robot, perhaps because the task appeared to be culturally neutral, and no self-assessment questionnaires were administered. Under this point of view, the current studies on the relationship between culture and attitudes towards robots face a limitation due to a disproportionate emphasis on self-assessment questionnaires over implicit, objective measures. Diana et al. [42] distinguish between explicit questionnaires and implicit tests, revealing that cultural influences are often evident in results obtained through explicit questionnaires. In the next part we provide an explanation to this issue.

4 Discussion

Based on the conducted analysis, we argue that culture can be clearly seen as a variable to be considered in robotics to improve HRI, trust, reliability and acceptance of technologies. However, culture is a broad concept that covers various aspects: verbal behavior, nonverbal behavior, design, and application areas. In the following, we try to summarize the common themes found in the reported works. We remark that the findings summarized here should be interpreted as reflecting culturally situated patterns as identified in existing studies, rather than as stable or exhaustive characterizations of cultural groups.

First *the impact of religion* (Sect. 3.1): it is clear that the influence of religion is an essential aspect, being also the one that has been investigated more in deep. A large number of research works propose the animistic background as an explanation for Japan's acceptability of robots, particularly humanoid robots. However, some research works [99, 112] have proposed a more detailed explanation, demonstrating that animism is not an identical concept for all cultures, but has different meanings and, thus, consequences in HRI. Also, although animistic tendencies can also be found in Western subjects, they do not lead to the same perception of robots in Japanese persons. Animism as a concept, in short, is declined according to different characteristics depending on the level of anthropocentrism of the culture. Religion, as discussed in some research works [55, 64, 87, 100] also conditions the choice of application areas and the boundaries that the robot should not trespass. There are social skills that some subjects expect the robot to exhibit, even for tasks that would seem to be unrelated to those skills, such as the prayer gesture that the Pakistani children expected iCat to perform [60].

Second, *nationality and aspects that enter in culture indirectly* (Sect. 3.2): a whole series of aspects, indirectly linked to culture and tradition, have an impact on the perception of robots, such as the technological diffusion in the country, media representations of robots or educational curricula provided by national institutions, being used to specific types of robots, and the different kinds of narratives that the media propose over time. The interference of these elements with cultural background can be key to better understanding and investigating contrasting results obtained by different research work.

Third, *the appearance and the application areas*: from a design perspective (Sect. 3.3), many elements have emerged as relevant in this context, and all of them need to be considered and implemented for realizing culturally competent robots, which, ultimately, seem to guarantee a more pleasant interaction with humans: the appearance, whether humanoid or non-humanoid (Sect. 3.4), the robot's applications and scenarios, its multifunctionality or specialization, the scope and limits of its capabilities (Sect. 3.5). At a glance, specialized, non-multitasking robots are preferred in societies where roles are strongly divided (Korea, Middle East), while also the communication capabilities of the robot should follow the hierarchical structure of the society. Here, people also expect the robot to exhibit its social position with the use of honorifics, expressions of politeness, and proper interpersonal distance. It must be said, however, that although some elements seem to be relevant to improve involvement, control, or trust, they do not necessarily affect the actual willingness of persons to use and purchase the robot, as shown in [56] and [57].

Fourth, *Hofstede's descriptors* (Sect. 3.4 and 3.5) can describe some differences between cultures. They show that individualist or collectivist, low- or high-context, feminine or masculine cultures influence different aspects of interaction with robots: acceptability, in-group perception, authoritativeness and persuasion of the robot, types of communication rules, which, if implemented in a way correlated with culture, should provide a more pleasant interaction.

Fifth, *verbal and non-verbal preferences*: the performed analysis seems to suggest that the rules philosophers of pragmatics (Sect. 3.4) have highlighted in the interaction between humans also seem to apply to the interaction with the robot, being their implementation a key factor in increasing the acceptability of robots. While culturally dependent components are relevant in HRI, some of the considered aspects, i.e. emotional expressions achieved through gait and mimicry, also need a solid contextual component (Sect. 3.3). For this reason, complex emotional states implemented by robotic platforms are often difficult to recognize by users when extensive information is lacking, even if robots are culturally aware. Indeed. such emotional conditions, to be correctly identified, require the intervention of a top-down interpretation function, which can be directly correlated to the context in which they occur. In other words, context concordance aids human perceptions of emotional expressions [79, 128]. Studies have also shown that symbols, such as lines and colors, that cartoonists add to their boards to aid the emotional recognition of characters also support the emotional identification of expressions in robotics (Sect. 3.3) but this is especially true only for the culture from which those symbols originate [31].

In addition to these elements of discussion, the analysis of related works shows that most of them investigated the effect of culture on the interaction between robots and humans without explaining it. Many works noted a statistically significant impact of cultural background on the HRI, or likability of the robot, or inspired trust, but only a few works (all of them quite recent) tried to offer an explanation for this phenomenon.

A limitation of the studies now carried on is that there is also a disproportion between studies using self-assessment questionnaires and studies considering implicit, objective measures. In [42], the authors make a distinction between questionnaires and implicit tests. Although this analysis states that results that link culture with robots are almost always obtained through explicit questionnaires, the research also shows that Japanese individuals have a more positive explicit attitude towards robots than Dutch individuals, but no evidence of such a difference was found at the implicit level. This finding may suggest that individuals are influenced by culture when the task explicitly prompts them to reflect on their cultural attitudes; in this scenario, culture acts as a guide in shaping responses during the self-assessment. The data obtained through self-assessment questionnaires, i.e., explicit, are measures that can be somehow biased by culture, since people are explicitly asked to evaluate the robot in linguistic terms. Therefore, cross-cultural differences in the explicit attitudes towards robots may exist, but these are not necessarily accompanied by implicit differences. Elisabetta Lalumera [7] proposes a similar analysis based on linguistic relativism. Indeed, she notices an influence of language on the perception of reality where the task demands are explicitly linguistic. For these reasons, researchers can focus on implicit measures, although to date there is no recognized implicit measure of attitudes towards artificial agents.

Moreover, the performed analysis also helped to reveal some common methodological flaws and biases related to the choice of the representative sample present in the experiments commonly performed in this context. For example, in [59], the absence of significant cultural differences between elderly Israelis and Austrians could be due to the fact that many of the Israeli participants had Austrian and German ancestry, hence the results did not highlight any cultural influence in the robot's perception. A similar bias has been identified in [109], in which Japanese students recruited at a university in Germany did not show any discomfort with the individualist robot, probably because they were acquainted with the German culture, since they were living and studying in Germany.

We can conclude here that, as humans, we are endowed with a series of response shortcuts provided to us by culture, language, personal history, group history, and physicality. Based on these, and depending on the contextual clues, we activate different patterns of action, by making implicit choices: thus culture intervenes as a response and interpretation strategy when a clear reference to social background is included in the task. or where communication is inevitable. Having robots, and social robots in particular, the need to have some predominant patterns of actions similar to humans, roboticists should include culture in the design and models of social robots, to achieve an effective HRI.

How to include those factors in software architecture for robotics is not trivial: indeed, the number of papers focusing on implementation aspects is quite limited. Some research works suggest that robots should follow the norms and social rules specific to the cultural background of persons with which it is interacting: however, such a view can easily fall into stereotypes, having individuals specific preferences and attitudes. In line with the strategy implemented in [19, 72, 124, 129] we propose here that cultural diversity awareness can be seen not as a bias, but as a principle of economy, i.e. thrift. In other words, if the robot has to interact with a specific group, or person, identifying themselves as belonging to a specific culture, it is of slight advantage to suggest an activity that is widespread in that culture as its first option. However, if the robot gets contradictory responses from its interactions, i.e. it learns the user's specific preferences and attitudes that can differ from the one typical of their cultural background, it can update its default output by suggesting alternative activities that better suit the individual in question.

This strategy also usually holds in human-human interactions. As humans, we use universal information in the absence of complete information to interpret the world surrounding us. Resuming the example given by Umberto Eco in "The Name of the Rose" [130],

If you see something from a distance, and you do not understand what it is, you will be content with defining it as a body of some dimension. When you come closer, you will then define it as an animal, even if you do not yet know whether it is a horse or an ass. And finally, when it is still closer, you will be able to say it is a horse even if you do not yet know whether it is Brunellus or Niger. And only when you are at the proper distance will you see that it is Brunellus (or, rather, that horse and not another, however you decide to call it). And that will be full knowledge, the learning of the singular.

In the introduction, we briefly mentioned Mansouri's paper [5] and his critique of the currently growing field of cultural robotics. Mansouri argues that the problem lies in the lack of a fixed definition of culture, leading to an absence of a clear object of study in this discipline. In reality, a lack of definition is common in various areas, including cognitive operations, mind, society, and culture, all lacking unanimous agreement. The point is that the search for a fixed and clear quid in categories should be surpassed, adopting an approach of weak relativism and framing concepts à la Wittgenstein in the Philosophische Untersuchungen [131] or Barsalou [132]. According to the latter, concepts are simulators, a set of strategies to refer to the world, flexibly retrievable depending on the situation. In other words, nothing is fixed.

Culture is not clear-cut; instead, it is one of the strategies to shorten the adaptation time to the world in a moment of ignorance. Culture intervenes to simplify choices, exactly as described through Umbert Eco's quote, cutting out that otherwise excessively complex domain with strategies. Thanks to living in a group, we learn to simplify reality in a flexible and pre-attentive way; that is, we have access to anticipations and interpretations of others' choices that would otherwise require too much time and knowledge. Culture, contrary to what one might think, does not add meaning but helps humans select information from a shared, real world that would otherwise be overwhelming for our computational resources.

We believe that Mansouri falls into the paradox already discussed by Hegel in the Phenomenology of Spirit [133]. Regarding Perception, Hegel showed that an object could be simultaneously framed under multiple categories, even contradictory ones: for example, the fact that the object could be one or many at the same time. This leads to a paradox, the same one that led skeptics to doubt the real existence of things. Similarly, since culture can be framed under different interpretative frames, there is a risk of doubting its existence, concluding the unnecessary need for a field dedicated to it. In reality, culture is a fuzzy, nuanced concept. Different perimeters can be carved out, and therefore, different definitions can be given due to the very nature of this conceptual framework. Contrary to the assumption that culture is a bias, it is, in fact, a principle of economy, an adaptation strategy to the world. If considered as fuzzy and flexible, it avoids perpetuating bias in robotics, as mentioned above.

To support conceptual flexibility and how culture determines responses, based on context and task objectives, we can also mention here the research work carried out in [74]. Even if concepts are "simulators" that incorporate different action procedures, elicited each time depending on the context, (i.e., in the case of the bodily ratio), if the task's goal is to define gender based on the robot's appearance, it does not draw from culture (which is irrelevant) but from the greater universality expressed by the human species' body. One is not dealing with appearance in clothing or culturally and nationally sensitive roles, but with a constant ratio. In a broader philosophical and cognitive discourse, the concept of conceptual flexibility is linked to the ability of individuals to adapt their cognitive strategies depending on the task at hand, using selective cognitive resources to avoid information overload. Concepts are not rigid and defined but "open simulators" that adapt to the specific context, reducing the risk of cognitive biases and informational collapse. Culture, seen as a heuristic learned through experience, contributes to selecting relevant information, but it is not decisive when dealing with universal phenomena like the perception of bodily proportions in robots. The selection of information, which happens at the cognitive level, is a dynamic process that adapts to the needs of the context and the task's objectives, avoiding the risk of information overload that would prevent effective understanding of reality [18].

In short, the robot can use cultural generalization as we do, perhaps by aggregating similar clusters, as suggested in [105]. The universal serves to speed up the adaptation to the individual, going towards a personalization that will be more precise through subsequent interactions. In other words, including cultural information makes autonomous communication and interaction less disruptive, and faster in defining the personal characteristics that make each human unique, still being embedded in their context.

5 Conclusion

This review work tries to summarize all efforts performed to identify the multifaceted interaction between culture and social robotics. The analysis of 95 scientific papers led to the identification of specific themes that arose in this context, i.e., the influence of religion, social skills, indirect aspects linked to culture, as well as some basic guidelines that should be followed by roboticists to improve engagement and enjoyment of users, and to evaluate the interaction. In general, the conclusion is that culture (besides the accordance on a unified definition) impacts the HRI, in particular when the task is social and the required skills are socially build and learnt. This influence explains the growing interest of the robotics community.

As a possibility for future investigations, researchers can test whether preferring culturally competent models reduces the robot's adaptation time: and whether the cultural variable represents an economic principle for robotics. Furthermore, it could be investigated whether, with implicit analyses and tasks conceived to not elicit cultural responses, culture ceases to have statistically relevant impacts on experimental outcomes.

Funding Open access funding provided by Università degli Studi di Genova within the CRUI-CARE Agreement.

Data Availability The data generated during the current study are available from the corresponding author upon reasonable request.

Declarations

Compliance with Ethical Standards The authors declare that they have no potential conflicts of interest related to this research. This research did not involve human participants

References

1. Briggs G, Scheutz M (2014) How robots can affect human behavior: investigating the effects of robotic displays of protest and distress. Int J Soc Robot 6:343–355
2. Broadbent E (2017) Interactions with robots: the truths we reveal about ourselves. Ann Rev Psychol Phychol 68:627–652
3. Dahl TS, Kamel Boulos MN (2013) Robots in health and social care: a complementary technology to home care and telehealthcare? Robotics 3(1):1–21
4. Kaasinen E, Anttila AH, Heikkilä P, Laarni J, Koskinen H, Väätänen A (2022) Smooth and resilient human-machine teamwork as an industry 5.0 design challenge. Sustainability 14(5):2773
5. Mansouri M, Taylor H (2023 December 29) Does cultural robotics need culture? Conceptual fragmentation and the problems of merging culture with robot design. Int J Soc Robot. https://doi.org/10.1007/s12369-023-01085-y
6. Lenard PT (2020) «Culture». In: The stanford encyclopedia of philosophy. A cura di Edward N. Zalta. Winter 2020. Metaphysics research Lab. Stanford University
7. Lalumera E (2013) Concetti, relativismo e strategie flessibili, RIFL 7(n. 3):62–70
8. Fedriga R, Saettone L, Micheli E (2023) Linguistic and cultural competencies in dynamic possible Worlds. In: CEUR Workshop Proceedings, vol 3595. CEUR-WS, pp 1–9. CEUR-WS.org
9. Fedriga R, Saettone L, Recchiuto C, Micheli E, Sgorbissa A (2024) Cultural competence through dynamic epistemic logic: a proposal for robotic Implementation. In 2023-I-RIM Conference, pp 43–45
10. James W (1890) The principles of psychology. Henry Holte Company, New York
11. Mead GH (1934) Mind, self, and society. University of Chicago Press, Chicago
12. Rossi P, C (2000) Dizionario di Filosofia. a cura di. La Nuova Italia, Firenze
13. Popper K (1945) The open society and its enemies. Routledge, London
14. Wikipedia contributors (2025 October 20) Hermeneutic circle. Wikipedia. https://en.wikipedia.org/wiki/Hermeneutic_circle
15. Tricco AC, Lillie E, Zarin W, O'brien K, Colquhoun H, Kastner M, Straus SE (2016) A scoping review on the conduct and reporting of scoping reviews. BMC Med Res Methodol 16:1–10
16. Williams T (2023 March) The eye of the robot Beholder: ethical risks of representation, recognition, and reasoning over identity characteristics in human-robot interaction. In Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction, pp 1–10
17. Saettone L, Fedriga R, Micheli E (2023) Linguistic and cultural competences in dynamic possible Worlds. RobOntics@ RO-Man
18. Fedriga R, Recchiuto C, Saettone L (2024) How representation organizes reality. Lexicon Philosophicum: Int J Hist Texts Ideas 11:19–38
19. Project http://caressesrobot.org/en/project/
20. RobOntics 2023 (n.d.) RobOntics 2023. https://robontics.github.io/
21. Arksey H, O'Malley L (2005) Scoping studies: towards a methodological framework. Int J Multiling Soc Res Methodol 8(1):19–32
22. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, Moher D (2014) Scoping reviews: time for clarity in definition, methods, and reporting. J Educ Chang Clin Epidemiol 67(12):1291–1294
23. Levac D, Colquhoun H, O'Brien KK (2010) Scoping studies: advancing the methodology. Implementation Sci 5:1–9
24. Bramer WM, Rethlefsen ML, Kleijnen J, Franco OH (2017) Optimal database combinations for literature searches in systematic reviews: a prospective exploratory study. Systematic Rev 6:1–12
25. Pham MT, Rajić A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA (2014) A scoping review of scoping reviews: advancing the approach and enhancing the consistency. Res Synth Methods 5(4):371–385
26. Hofstede G (2011) Dimensionalizing cultures: the Hofstede model in context. Online Readings Phychol Culture 2(1):8
27. Corbin J, Strauss A (2008) Basics of qualitative research: techniques and procedures for developing grounded theory, 3rd edn edn. Sage Publications, Inc. https://doi.org/10.4135/9781452230153
28. Gasteiger N, Hellou M, Ahn HS (2021) Factors for personalization and localization to Optimize human-robot interaction: a literature review. Int J Soc Robot
29. Le Quyen Dang T, Tuyen NTV, Jeong S, Chong NY (2017 January) Encoding cultures in robot emotion representation (2017) RO-MAN, 2017 - 26th IEEE International Symposium on robot and human Interactive Communication (pp 547–552
30. Trovato G, Zecca M, Do M, Terlemez Ö, Kuramochi M, Waibel A, Asfour T, Takanishi A (2015) A novel greeting selection system for a culture-adaptive humanoid robot. Int J Adv Robot Syst 12
31. Kishi T, Futaki H, Trovato G, Endo N, Destephe M, Cosentino S, Hashimoto K, Takanishi A (2014) Development of a comic mark based expressive robotic head adapted to Japanese cultural background. In IEEE International Conference on Intelligent Robots and Systems, art. no. 6942918, pp. 2608–2613
32. Cooney M, Shiomi M, Duarte EK, Vinel A (2023) A broad view on robot self-defense: rapid scoping review and cultural comparison. Robotics 12(2):43
33. Ohkura M, Sugaya M, Sripian P, Laohakangvalvit T, Chiba H, Berque D (2022) Design and implementation of kawaii robotic gadgets in virtual spaces by Japanese and American University students in a remote collaboration project. Int J Soc Res Methodol Affective Eng 21(2):143–150
34. Abdelhakim AS, Abou-Shouk M, Ab Rahman NAFW, Farooq A (2023) The fast-food employees' usage intention of robots: a cross-cultural study. Tour Manag Perspectives 45:101049
35. Papadopoulos I, Koulouglioti C, Lazzarino R, Ali S, Wright S, Martín-García Á, Nissim S (2023) Views about perceived training needs of health care professionals in relation to socially assistive robots: an international online survey. Contemp Nurse 59(4–5):344–361
36. Pitardi V, Bartikowski B, Osburg VS, Yoganathan V (2023) Effects of gender congruity in human-robot service interactions: the moderating role of masculinity. Int J Inf Manage 70:102489
37. Marchesi S, Abubshait A, Kompatsiari K, Wu Y, Wykowska A (2023) Cultural differences in joint attention and engagement in mutual gaze with a robot face. Sci Rep 13(1):11689

38. Chi OH, Chi CG, Gursoy D, Nunkoo R (2023) Customers' acceptance of artificially intelligent service robots: the influence of trust and culture. Int J Inf Manage 70:102623
39. Oh JY, Bennett CC (2023 March) The answer lies in user experience: qualitative comparison of US and South Korean perceptions of In-home robotic pet interactions. In Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction, pp 306–310
40. Dang J, Liu L (2023) Do lonely people seek robot companionship? A comparative examination of the loneliness-robot anthropomorphism link in the United States and China. Comput Hum Behav 141:107637
41. Fraune MR, Komatsu T, Preusse HR, Langlois DK, Au RHY, Ling K, Suda S, Nakamura K, Tsui KM (2022) Socially facilitative robots for older adults to alleviate social isolation: a participatory design workshop approach in the US and Japan. Front Phychol 13, art. no. 904019
42. Diana F, Kawahara M, Saccardi I, Hortensius R, Tanaka A, Kret ME (2022) A cross-cultural comparison on implicit and explicit attitudes towards artificial agents. Int J Soc Robot
43. Alemi M, Abdollahi A (2021) A cross-cultural investigation on attitudes towards social robots: Iranian and Chinese University students. J Higher Educ Policy Leadersh Stud 2(3):120–138
44. Zhang M, Xu T, Hardin J, Cai JJ, Brooks J, Green KE (2021) How many robots do you want? A cross-cultural exploration on user preference and perception of an assistive multi-robot system. In 2021 30th IEEE International Conference on Robot and Human Interactive Communication, RO-MAN 2021, pp 580–585
45. Dang J, Liu L (2021) Robots are friends as well as foes: ambivalent attitudes toward mindful and mindless AI robots in the United States and China. Comput Hum Behav 115, art. no. 106612
46. Bröhl C, Nelles J, Brandl C, Mertens A, Nitsch V (2019) Human-robot collaboration acceptance model: development and comparison for Germany, Japan, China and the USA. Int J Soc Robot 11(5):709–726
47. Brito IV, Freire EO, Carvalho EAN, Molina L (2019) Analysis of cross-cultural effect on gesture-based human-robot interaction. Int J Surg Pathol Mech Eng Robot Res 8(6):852–859
48. Vannucci F, Sciutti A, Lehman H, Sandini G, Nagai Y, Rea F (2019) Cultural differences in speed adaptation in human-robot interaction tasks. Paladyn 10(1):256–266
49. Bernotat J, Eyssel F (2018) Can('t) Wait to have a robot at home? - Japanese and German users' attitudes toward service robots in Smart Homes. RO-Man, 2018 - 27th IEEE Int Symp Robot Hum Interact Commun, art. no. 8525659, pp. 15–22
50. Tay TT, Low R, Loke HJ, Chua YL, Goh YH (2018) Uncanny valley: a preliminary study on the acceptance of Malaysian urban and rural population toward different types of robotic faces. IOP Conf Ser: Mater Sci Eng 344(1), art. no. 012012
51. Bruno B, Chong NY, Kamide H, Kanoria S, Lee J, Lim Y, Pandey AK, Papadopoulos C, Papadopoulos I, Pecora F, Saffiotti A, Sgorbissa A (2017) Paving the way for culturally competent robots: a position paper . In RO-MAN, 2017- 26th IEEE International Symposium on Robot and Human Interactive Communication, 2017-January, pp. 553–560
52. Nomura T (2017) Cultural differences in social acceptance of robots. In RO-MAN, 2017 -26th IEEE International Symposium on Robot and Human Interactive Communication, 2017-January, pp. 534–538
53. Rudovic O, Lee J, Mascarell-Maricic L, Schuller BW, Picard RW (2017) Measuring engagement in robot-assisted autism Therapy: a crosscultural study. Front Robot AI 4, art. no. 36
54. Haring KS, Silvera-Tawil D, Takahashi T, Velonaki M, Watanabe K (2015) Perception of a humanoid robot: a cross-cultural comparison. In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, 2015-November, art. no. 7333613, pp. 821–826
55. Destephe M, Brandao M, Kishi T, Zecca M, Hashimoto K, Takanishi A (2015) Walking in the uncanny valley: importance of the attractiveness on the acceptance of a robot as a working partner. Front Phychol 6:204
56. Conti D, Cattani A, Di Nuovo S, Di Nuovo A (2015) A cross-cultural study of acceptance and use of robotics by future psychology practitioners. In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, 2015-November, art. no. 7333601, pp. 555–560
57. Lee H, Kang H, Kwak SS, Lee J, Kim M-G, Kwon J (2015) How people perceive human-and product-like robots: cross-cultural analysis between Japan and Korea. In HAI, 2015 - Proceedings of the 3rd International Conference on Human-Agent Interaction, pp 315–318
58. Fraune MR, Kawakami S, Šabanović S, De Silva PRS, Okada M (2015) Three's company, or a crowd?: the effects of robot number and behavior on HRI in Japan and the USA. Robot: Sci Syst 11
59. Torta E, Werner F, Johnson DO, Juola JF, Cuijpers RH, Bazzani M, Oberzaucher J, Lemberger J, Lewy H, Bregman J (2014) Evaluation of a small socially-assistive humanoid robot in Intelligent Homes for the care of the elderly. J Intell Rob Syst: Theory Appl 76(1):57–71
60. Shahid S, Krahmer E, Swerts M (2014) Terms and conditions Privacy policy child-robot interaction across cultures: how does playing a game with a social robot compare to playing a game alone or with a friend? Comput Hum Behav 40:86–100
61. Lee HR, Šabanović S (2014) Culturally variable preferences for robot design and use in South Korea, Turkey, and the United States. In ACM/IEEE International Conference on Human-Robot Interaction, pp 17–24
62. Giuliani M, Petrick RPA, Foster ME, Gaschler A, Isard A, Pateraki M, Sigalas M (2013) Comparing task-based and socially intelligent behaviour in a robot bartender. In ICMI, 2013 - Proceedings of the 2013 ACM International Conference on Multimodal Interaction, pp 263–270
63. Coeckelbergh M (2012) Can we trust robots? Ethics Inf Technol 14:53–60
64. Mavridis N, Katsaiti M-S, Naef S, Falasi A, Nuaimi A, Araifi H, Kitbi A (2012) Opinions and attitudes toward humanoid robots in the middle East. AI Soc 27(4):517–534
65. Weiss A, Van Dijk B, Evers V (2012) Knowing me knowing you: exploring effects of culture and context on perception of robot personality. In ICIC, 2012 - Proceedings of the 4th International Conference on Intercultural Collaboration, pp 133–136
66. Shahid S, Krahmer E, Swerts M, Mubin O (2011) Who is more expressive during child-robot interaction: Pakistani or Dutch children? In HRI, 2011 - Proceedings of the 6th ACM/IEEE International Conference on Human-Robot Interaction, pp 247–248
67. Rau PLP, Li Y, Li D (2010) A cross-cultural study: effect of robot appearance and task. Int J Soc Robot 2(2):175–186
68. Coeckelbergh M (2009) Personal robots, appearance, and human good: a methodological reflection on roboethics. Int J Soc Robot 1:217–221
69. Bartneck C (2008) Who like androids more: Japanese or US Americans? In Proceedings of the 17th IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN, art. no. 4600724, pp. 553–557
70. Nomura T, Kanda T, Suzuki T, Han J, Shin N, Burke J, Kato K (2007) Implications on humanoid robots in pedagogical applications from cross-cultural analysis between Japan, Korea, and the USA. In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, art. no. 4415237, pp. 1052–1057

71. Lubitz A, Gutzeit L, Kirchner F (2023 August) CoBaIR: a python library for context-based intention recognition in human-robot-interaction. In 2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), IEEE (pp. 2003–2009
72. Recchiuto CT, Sgorbissa A (2020) A Feasibility study of culture-Aware Cloud Services for conversational robots. IEEE Robot Automation Lett 5(4), art. no. 9165168, pp. 6559–6566
73. Rudovic O, Utsumi Y, Lee J, Hernandez J, Ferrer EC, Schuller B, Picard RW (2018 October) CultureNet: a deep learning approach for engagement intensity estimation from face images of children with autism. In 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE (pp. 339–346
74. Trovato G, Lucho C, Paredes R (2018) She's electric-the influence of body proportions on perceived gender of robots across cultures. Robotics 7(3):50
75. Viet Tuyen NT, Jeong S, Chong NY Emotional bodily expressions for culturally competent robots through long term human-robot interaction (2018) IEEE International Conference on Intelligent Robots and Systems, art. no. 8593974, pp. 2008–2013
76. Chen C, Jack RE (2017) Discovering cultural differences (and similarities) in facial expressions of emotion. Curr Opin Psychol 17:61–66
77. Lugrin B, Frommel J, André E (2015 October) Modeling and evaluating a bayesian network of culture-dependent behaviors. In 2015 International Conference on Culture and Computing (Culture Computing), IEEE (pp. 33–40
78. Izui T, Milleville I, Sakka S, Venture G (2015) Expressing emotions using gait of humanoid robot. In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, 2015-November, art. no. 7333614, pp. 241–245
79. Bennett CC, Sabanovic S, Fraune MR, Shaw K (2014) Context congruency and robotic facial expressions: do effects on human perceptions vary across culture? IEEE RO-Man, 2014 - 23rd IEEE Int Symp Robot Hum Interact Commun: Hum Rob Co-Existence: Adapt Interface Syst Dly Life, Ther, Assistance Socially Engaging Interact, art. no. 6926296, pp. 465–470
80. Trovato G, Kishi T, Endo N, Zecca M, Hashimoto K, Takanishi A (2013) Cross-cultural perspectives on emotion expressive humanoid robotic head: recognition of facial expressions and symbols. Int J Soc Robot 5(4):515–527
81. Botzheim J, Obo T, Kubota N (2012) Human gesture recognition for robot partners by spiking neural network and classification learning. In 6th International Conference on Soft Computing and Intelligent Systems, and 13th International Symposium on Advanced Intelligence Systems, SCIS/ISIS 2012, art. no. 6505305, pp. 1954–1958
82. Becker-Asano C, Ishiguro H (2011) Evaluating facial displays of emotion for the android robot Geminoid F. IEEE SSCI, 2011 - Symp Ser Comput Intel - WACI 2011: 2011 Workshop Affective Comput Intel, art. no. 5953147, pp. 22–29
83. Bächle TC (2023) Faking it deeply and universally? Media forms and epistemologies of artificial faces and emotions in Japanese and Euro-American contexts. Convergence 29(2):496–518
84. Grassini S, Ree AS (2023 September) Hope or Doom AI-ttitude? Examining the impact of gender, age, and cultural differences on the Envisioned future impact of artificial Intelligence on Humankind. In Proceedings of the European Conference on Cognitive Ergonomics 2023, pp 1–7
85. Yam KC, Tan T, Jackson JC, Shariff A, Gray K (2023) Cultural differences in People's Reactions and applications of robots. Algoritms, Artif Intel. Manag Organ Rev 1–17
86. Robert LP (2021) Contextualizing human-Automated Vehicle interactions: a socio-Ecological framework. Robotics 10(3):92
87. Korn O, Akalin N, Gouveia R (2021) Understanding cultural Preferences for social robots: a study in German and Arab communities. ACM Trans Hum Rob Interact 10(2), art. no. 12
88. Erden MS (2020) Social robotics and Engineering students: do they Match? Does culture Matter? Int J Soc Robot 12(5):1149–1157
89. Turja T, Oksanen A (2019) Robot acceptance at work: a Multilevel analysis based on 27 EU countries. Int J Soc Robot 11(4):679–689
90. Yu C-E, Ngan HFB (2019) The power of head tilts: gender and cultural differences of perceived human vs human-like robot smile in service. Tour Rev 74(3):428–442
91. Bartneck C, Suzuki T, Kanda T, Nomura T (2007) The influence of people's culture and prior experiences with Aibo on their attitude towards robots. AI Soc 21(1):217–230
92. Kim B, Wen R, Zhu Q, Williams T, Phillips E (2021) Robots as moral advisors: the effects of deontological, virtue, and confucian role ethics on encouraging honest behavior. In ACM/IEEE International Conference on Human-Robot Interaction, art. no. 3446908, pp. 10–18
93. Chikaraishi T, Yoshikawa Y, Ogawa K, Hirata O, Ishiguro H (2017) Terms and conditions Privacy policy Creation and staging of android theatre "Sayonara" towards developing highly human-like robots. Future Internet 9(4), art. no. 75
94. Kamide H, Arai T (2017) Perceived Comfortableness of Anthropomorphized robots in U.S. and Japan. Int J Soc Robot 9(4):537–543
95. Franco A, Roach SS (2023) Demographic factors Affecting Receptivity of humanoid robots in Thailand: an empirical study. Thammasat Rev 26(1):24–56
96. Ikari S, Sato K, Burdett E, Ishiguro H, Jong J, Nakawake Y (2023) Religion-related values differently influence moral attitude for robots in the United States and Japan. J Retailing Cross-Cult Phychol 54(6–7):742–759
97. Sakura O Robot and ukiyo-e: implications to cultural varieties in human-robot relationships (2022. AI Soc 37(4):1563–1573
98. Castelo N, Sarvary M (2022) Cross-cultural differences in comfort with Humanlike robots. Int J Soc Robot 14(8):1865–1873
99. Spatola N, Marchesi S, Wykowska A (2022) Different models of anthropomorphism across cultures and ontological limits in current frameworks. Front Robot AI 9, art. no. 863319
100. Samani H, Saadatian E, Pang N, Polydorou D, Fernando ONN, Nakatsu R, Koh JTKV (2013) Cultural robotics: the culture of robotics and robotics in culture. Int J Adv Robot Syst 10(12):400
101. Engwall O, Cumbal R, Majlesi AR (2023) Socio-cultural perception of robot backchannels. Front Robot AI 10:988042
102. Bennett CC, Bae YH, Yoon JH, Chae Y, Yoon E, Lee S, Weiss B (2023) Effects of cross-cultural language differences on social cognition during human-agent interaction in cooperative game environments. Comput Speech Language 81:101521
103. Seok S, Hwang E, Choi J, Lim Y (2022 March) Cultural differences in indirect Speech act use and politeness in human-robot interaction (2022). In ACM/IEEE International Conference on Human-Robot Interaction, pp 470–477
104. Kumar S, Halloun S, Itzhak E, Tractinsky N, Nimrod G, Edan Y (2022) Exploring the influence of culture and gender on older adults' perception of polite robots. In RO-MAN, 2022 - 31st IEEE International Conference on Robot and Human Interactive Communication: Social, Asocial, and Antisocial Robots, pp 1038–1043
105. Marchesi S, Roselli C, Wykowska A (2021) Cultural values, but not nationality, Predict social inclusion of robots. Lect Notes Comput Sci (Incl Subser Lect Notes Artif Intel Lect Notes Bioinf) 13086 LNAI:48–57
106. Bhavnani CV, Rolf M (2020) Attitudes towards a handheld robot that learns proxemics. In ICDL-EpiRob 2020- 10th IEEE

International Conference on Development and Learning and Epigenetic Robotics, art. no. 9278098
107. Depka Prondzinska A, Fischer K (2020 March) Using robots to study the perception of feedback cross-culturally. In Companion of the 2020 ACM/IEEE International Conference on Human-Robot Interaction, pp 186–188
108. Shidujaman M, Mi H, Jamal L (2020) "I trust you more": a Behavioral greeting gesture study on social robots for Recommendation tasks. In Proceedings of International Conference on Image Processing and Robotics, ICIPRoB 2020, art. no. 9367364
109. Lugrin B, Bartl A, Striepe H, Lax J, Toriizuka T (2018) Do i act familiar? Investigating the Similarity-Attraction principle on culture-specific Communicative behaviour for social robots. In IEEE International Conference on Intelligent Robots and Systems, art. no. 8594035, pp. 2033–2039
110. Shen S, Tennent H, Claure H, Jung M (2018) My telepresence, my culture? An intercultural investigation of telepresence robot operators' interpersonal distance behaviors. In Conference on Human Factors in Computing Systems - Proceedings, 2018-April
111. Shidujaman M, Mi H (2018) "Which country are you from?" a cross-cultural study on greeting interaction design for social robots. Lect Notes Comput Sci (Incl Subser Lect Notes Artif Intel Lect Notes Bioinf) 10911 LNCS, pp. 362–374
112. Trovato G, Eyssel F (2017) Mind attribution to androids: a comparative study with Italian and Japanese adolescents. In RO-MAN, 2017- 26th IEEE International Symposium on Robot and Human Interactive Communication, 2017-January, pp. 561–566
113. Mussakhojayeva S, Sandygulova A (2017) Cross-cultural differences for adaptive strategies of robots in public spaces. In RO-MAN, 2017- 26th IEEE International Symposium on Robot and Human Interactive Communication, 2017-January, pp. 573–578
114. Andrist S, Ziadee M, Boukaram H, Mutlu B, Sakr M (2015) Effects of culture on the credibility of robot Speech: a comparison between English and Arabic. In ACM/IEEE International Conference on Human-Robot Interaction, 2015-March, pp. 157–164
115. Joosse MP, Poppe RW, Lohse M, Evers V (2014) Cultural differences in how an engagement-seeking robot should approach a group of people. In CABS, 2014 - Proceedings of the 5th ACM International Conference on Collaboration Across Boundaries, pp 121–130
116. Eresha G, Haring M, Endrass B, Andre E, Obaid M Investigating the influence of culture on proxemic behaviors for humanoid robots (2013). In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, art. no. 6628517, pp. 430–435
117. Trovato G, Zecca M, Sessa S, Jamone L, Ham J, Hashimoto K, Takanishi A (2013) Towards culture-specific robot customisation: a study on greeting interaction with Egyptians. In Proceedings - IEEE International Workshop on Robot and Human Interactive Communication, art. no. 6628520, pp. 447–452
118. Wang L, Rau P-LP, Evers V, Robinson BK, Hinds P (2010) When in Rome: the role of culture and context in adherence to robot recommendations. In 5th ACM/IEEE International Conference on Human-Robot Interaction, HRI 2010, pp 359–366
119. Rau PLP, Li Y, Li D (2009) Effects of communication style and culture on ability to accept recommendations from robots. Comput Hum Behav 25(2):587–595
120. Lin W, Rau P-LP, Evers V, Robinson B, Hinds P (2008) Responsiveness to robots: effects of ingroup orientation & communication style on HRI in China. In Proceedings of the 4th ACM/IEEE International Conference on Human-Robot Interaction, HRI'09, pp 247–248
121. Evers V, Maldonado HC, Brodecki TL, Hinds PJ (2008) Relational vs. group self-construal: untangling the role of national culture in HRI. In HRI, 2008 - Proceedings of the 3rd ACM/IEEE International Conference on Human-Robot Interaction: Living with Robots, pp 255–262
122. Ikeuchi H (2010) Animistic thinking in adults: the memorial service for dolls as a voluntary loss. Jpn J Soc Phychol 25(3):167–177
123. Suzuki Y, Kino K (2008) Development of the multidimensional empathy Scale (MES): focusing on the distinction between self-and other-orientation. Jpn J Educ Psychol 56(4):487–497
124. Gjaci A, Recchiuto CT, Sgorbissa A (2022) Towards culture-Aware Co-Speech gestures for social robots. Int J Soc Robot 14(6):1493–1506
125. Thomas JA (1985) The language of power: towards a dynamic pragmatics. J Pragmat 9(6):765–783
126. Kittler MG, Rygl D, Mackinnon A (2011) Special review article: beyond culture or beyond control? Reviewing the use of Hall's high-/low-context concept. Int J Cross Cult Manag 11(1):63–82
127. Waytz A, Gray K, Epley N, Wegner DM (2010) Causes and consequences of mind perception. Trends Cogn Sci 14(8):383–388
128. Saettone L, Bogliolo M, Micheli E (2021) Facial Emotion Recognition nell'Educazione: rischio o opportunità?, paper43, Didamatica-XXXX
129. Bruno B, Menicatti R, Recchiuto CT, Lagrue E, Pandey AK, Sgorbissa A (2018 June) Culturally-competent human-robot verbal interaction. In 2018 15th International Conference on Ubiquitous Robots (UR), IEEE (pp. 388–395
130. Eco U (1980) Il nome della Rosa. Bompiani, Milano
131. Wittgenstein L, Untersuchungen P. Anscombe, E. M., Rhees, Rush, 1953) Philosophical investigations, a cura di G. Oxford, Blackwell, 1958
132. Barsalou LW (2008 January 1) Grounded cognition. Ann Rev Psychol Phychol 59(1):617–645. https://doi.org/10.1146/annurev.psych.59.103006.093639
133. Hegel GWF (2019 September 30) The Phenomenology of spirit. University of Notre Dame Pess

Lorenza Saettone is a PhD student in Social Robotics at the Department of Informatics, Bioengineering, Robotics and Systems Engineering (DIBRIS), University of Genoa, and has been a visiting student at the Biovision Lab, INRIA Research Centre at Université Côte d'Azur, where she conducted research on virtual reality. Her academic background is in Philosophy, with a specialization in epistemology, language, and cognitivism. She is also a writer and game designer and collaborates with cultural and research institutions including Treccani, the University of Bologna, Fondazione Umberto Eco, Mondadori, and Feltrinelli.

Antonio Sgorbissa is Full Professor at the Università degli Studi of Genova and Coordinator of the national Doctorate in Robotics and Intelligent Machines (DRIM). He teaches Real-Time Operating Systems, Social Robotics and Ambient Intelligence in EMARO+, the European Master in Advanced Robotics. He also teaches theatrical techniques for public speaking to PhD students. His research interests include Autonomous Robotic Behaviour, with a focus on Social Robotics and Autonomous Robots for inspection and search&rescue. He is cofounder and a researcher of the RICE lab, Robots and Intelligent systems for Citizens and the Environment, rice.dibris.unige.it

Carmine Tommaso Recchiuto is Associate Professor at the University of Genoa. His work tries to bridge technological innovation in robotics with societal needs, aiming to develop intelligent solutions for real-world applications. He has co-founded the RICE laboratory (Robots and Intelligent Systems for Citizens and the Environment) at DIBRIS, which focus on social assistive robots and autonomous systems for environmental monitoring and disaster response. He is coordinating the projects SONRIE (focusing on Intercultural Robotics Pedagogy), ARIA (socially assistive robots for Alzheimer's care), and PROPER (aimed at developing cognitive systems for generating synthetic robot personalities). He is also contributing to the PNRR project RAISE, focusing on urban technologies for inclusive engagement.