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IS TECHNOLOGY GENDER NEUTRAL? A SYSTEMATIC LITERATURE REVIEW ON GENDER STEREOTYPES ATTACHED TO ARTIFICIAL INTELLIGENCE

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Abstract: Artificial Intelligence implies computer systems capable of mimicking human-like intelligence and competencies. In the nowadays society it is an exciting topic, thus, technology's gender features and roles are of great interest as well. As the literature is still scarce and inconsistent, the present paper aims to develop a systematic literature review on gender stereotypes attached to technology (virtual assistants and robots). The main goals are to emphasize the labels given to technology from a gender perspective, the perceived competencies of the gendered technology, the most relevant variables responsible for the way gender issues are perceived in connection with technology, and the proposed solutions for diminishing the technology gender stereotypes. Forty-five scientific papers have been selected and analyzed. Findings suggest that the most intelligent technologies are designed as females, male-gendered technology performs better in task-solving, and users' age and technology's visual representation are important variables in perception.

Keywords: *Gender stereotypes; Artificial intelligence; Virtual assistants; Robots; Systematic literature review.*

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INTRODUCTION

Stereotypes imply placing a piece of information into a certain category based on the type of data it has stored (Brahnam & De Angeli, 2012). While gender stereotypes are believed to affect the way individuals perceive and interpret information about themselves, they also shape the expectations of others (Ellemers, 2018). Gender stereotypes are both descriptive, meaning that they are formed around a characteristic a man or a woman possesses, and prescriptive, which reflects the social perception of what a person should be according to their gender (Brahnam & De Angeli, 2012). Stereotypes are explained through social role theory, which infers that once individuals form strong gender beliefs, they associate these beliefs with social roles that are specific to men or women (Hentschel et al., 2019; Guo et. al., 2020). These presumptions manifest both in home environment and at work (Hentschel et al., 2019; Guo et. al., 2020). Social roles refer to expectations regarding behavior (Guo et. al., 2020). They influence the perceptions concerning the adequate occupation for men and women (Guo et. al., 2020). Unfortunately, in social interactions this aspect is usually harmful and can lead to several biased preconceptions that are not in accordance with reality. Gender stereotypes are irrational beliefs related to the gender of the individual, suggesting that women and men are behaving in a specific manner because of their gender (Brahnam & De Angeli, 2012). Stereotypes can induce incorrect assessments that can bias decisions or expectations of performance (Hentschel et al., 2018; Hentschel et al., 2019). These biases are typical also for employers in their managerial decisions regarding female employees (Samoliuk et al., 2022) which, in their turn, encourage women to seek new possibilities with higher-paid positions (Lauzadyte-Tutliene & Mikuciauskaite, 2022). No doubt, some gender-related issues can influence the organizational outcomes, especially in services (Shava, 2021). These cognitions are deeply entrenched in the individual's mind and are very difficult to change (Brahnam & De Angeli, 2012).

Stereotypes are so powerful that not only are they generated in the human-to-human interactions, they are also applied to non-human entities (Brahnam & De Angeli, 2012). The relation between technology and gender stereotypes started to become a subject of interest in the 1990's, when the presence of stereotypes was identified in interactions with computers (Nass, Moon, & Green, 1997).

Artificial intelligence (AI) is a relatively new technology that had its debut in the 1950' and rapidly evolved into the most fascinating topic of interest among all new technologies today (Helm et al., 2020). AI can be defined as the ability of a machine to simulate human intelligence. This process often consists of a progressive learning experience in which an intelligent agent is assimilating information in the same manner an individual does (Zhang & Lu, 2021). As a research topic, AI is applied in several fields of activities and disciplines and presents different approaches (Zhang & Lu, 2021). AI is divided in multiple typologies consisting into analytical, human-inspired or humanized versions (Haenlein & Kaplan, 2019). Its level of development and thus, intelligence, also varies from basic intelligence performance to super intelligence (Haenlein & Kaplan, 2019).

The emergence of AI creates new research perspectives for the study of stereotypes, especially since the link between gender perceptions on technology is contradictory. On one hand, the literature emphasizes that gender stereotypes are problematic, and they affect interactions with technology (Thellman et al., 2018), potentially threatening real-life

interactions. Studies are focusing on the lack of perceived competence in female virtual agents (Ahn, Kim, & Sung, 2022), as well as on associations of virtual assistants with specific gender roles such as nurse (Tay, Jung, & Park, 2014) or housekeeper (Eyssel & Hegel, 2012). They can also be sexually abused and denigrated while interacting with individuals, which is worrying (Veletsianos, Scharber, & Doering, 2008). On the other hand, in many instances, female virtual assistants are perceived as being more trustworthy than male agents and they are preferred in performing some specific activities (Pfeuffer et al., 2019; Guo et al., 2020; Borau et al., 2021).

In this context, the present paper aims to offer a systematic literature review on the way gender stereotypes are attached to AI in general and to virtual assistants and robots in particular. To our knowledge, a theoretical review that aims to systematically cover the knowledge and understandings on the way technology triggers gender labels has not been done before. The proposed research questions are the following:

RQ1. Which are the labels given to technology from a gender perspective?

RQ2. How are the gender stereotypes affecting the perceived competence of virtual assistants and robots?

RQ3. What variables are responsible for perceived gender stereotypes on AI?

RQ4. What solutions for diminishing the technology gender stereotypes are proposed in the literature?

As the interaction between humans and technology is increasing in all domains and the phenomenon of gender stereotyping is more and more present in daily life, the relevance of the study is twofold. First, at the scientific level, emphasizing the most frequent causes for gender stereotyping and their effect on human-machine interaction, the paper fills in the literature gap and offers a practical basis for future studies. Second, at the business level, the review can serve as a basis for further technical decisions. By understanding the communication patterns of individuals when interacting with technology, engineers and technology designers can help diminish the gender stereotypes present in human-computer interaction.

The existing results are still to be debated and explored. First, the literature has not yet reached an agreement on which intelligent technologies are more likely to be the object of stereotyping, virtual assistants, chatbots, robots, or computers. At the same time, the age and race of the AI can influence the overall perception. Second, existing studies emphasize a general interest in user gender, trying to observe if males or females are more likely to exhibit stereotypical opinions on technology. Moreover, perceived trust, warmth and compassion are paramount variables addressed.

Technology and Gender Stereotypes

Anthropomorphization can be described as the tendency of individuals to attribute human characteristics to animals or objects (Ahn, Kim, & Sung, 2022). In the technological context, the most common scientific base for machine anthropomorphization refers to Computers as Social Actors paradigm (CASA). The theory has been developed by Clifford Nass and explains the communication process between humans and technology (Nass & Moon, 2000). It suggests that individuals act in relation with technology in the same manner as they do with other humans. Thus, computers become social actors because individuals retain the same patterns of interpersonal communication while interacting with them (Guzman, Lewis, 2019).

This paradigm is explored throughout most of the studies referring to virtual agents or artificial assistants. Many technologies are created to follow several human traits for a higher level of accessibility to the public. Literature suggests that individuals prefer interacting with humanized entities and have different preferences for agent personality and traits (Cercas Curry, Robertson, & Riser, 2020).

Studies have shown that stereotypes apply to technology and the evaluation of different cues impact several perceived competence items. Usually, female-gendered technology is perceived as having lower levels of trustworthiness and intelligence, compared to the technology that embodies a man, but higher levels of warmth and empathy (Haake & Gulz, 2008)

It is emphasized that stereotypes are more likely to occur when technology is used in domains that are specific for one of the genders, rather than in gender neutral ones. Thus, when technology embodies a woman, individuals perceive its competence higher in domains that are typical for women, compared to technical or other occupations that are labeled as being specific for men. Similarly, technology that embodies men is perceived as more competent when performing tasks of its gender. Gender stereotypes are less likely to occur in technology where the performed task is gender neutral, suggesting that individuals are not consciously discriminating gendered technology, but they unconsciously apply the stereotypes in the virtual environment (McDonnell & Baxter, 2019; Dufour & Ehrwein Nihan, 2016). Individuals are usually inclined to prefer female-gender technology. This preference is due to the perceived warmth and emotions. Studies on AI particularly mention that humans are inclined to favour technology that is more humanized, and they underline that female technology is perceived as being more humanlike than male one. As technology lacks emotions and warmth in particular, this is assumed to be the rationale behind human preference for female-gendered technology (Borau, Otterbring, Laporte, & Fosso Wamba, 2021).

Even if individuals prefer female-gendered technology, they perceive it as less competent compared to male technical embodiment (Ernst & Herm-Stapelberg, 2020; Lee, 2003; Ahn, Kim, & Sung, 2022). Previous studies mention that a male computer voice is perceived as more valid than a female one and thus, it is suggested that its competence level, as well as effectiveness, is higher due to this bias. Moreover, dominant traits are preferable for male-gendered technology rather than female , which have high implications to the way society position itself regarding problematic gender roles (Ahn, Kim, & Sung, 2022).

As gender affects the way agents are perceived (Lee, 2003), both women and men are more focused in solving correctly different tasks for the opposite virtual agent gender (Lee, 2003; Reich-Stiebert & Eyssel, 2017). Men are more likely to be persuaded by female agents and find them trustworthy (Lee, 2003), while females could perceive a male agent in a similar way to the female one (Guo et al., 2020). The level of stereotyping is also age correlated. Individuals' age and gender have a major influence on the way they perceive gendered technology (Watkins & Pak, 2020). Older individuals are perceiving male and female gendered agents differently compared to younger ones, as they have stronger stereotypical believes towards women (Watkins & Pak, 2020; Ladwig & Ferstl, 2018). Therefore, female agents are perceived as having lower competence in comparison with their male counterparts (Watkins & Pak, 2020; Ladwig & Ferstl, 2018). The degree on which the stereotypes are reinforced in communication with different types of technology depends on situational contexts, such as tasks the robots are required to perform or the environment in which is applied (Nomura & Kinoshita, 2015).

Artificial Intelligence and Gender Stereotypes

The most recent research approaches on technology and gender are oriented towards artificial intelligence (e.g., robots, virtual assistants). AI is defined as a computer-based system able to reproduce human-like characteristics, as intelligence and capabilities, as closely as possible (Townsend & Hunt, 2019; Woinaroschy, 2020). AI is able to generate images, recognize and understand language, speech, and visual items, make decisions and actively interact with individuals (Adams, 2019; Dornis, 2020). By using natural language processing, machine learning, automated reasoning, computer vision, and robotics, AI has become a significant part of our daily normal (e.g., GPS navigation, personal assistants, chatbots etc.) (Townsend & Hunt, 2019; Mezei, 2020).

Although AI is born as a gender-neutral entity, the literature mentions the impaired judgment of the individuals regarding a gendered AI, which impact the interaction between those two. Individuals unconsciously apply the categorization process which, in this case, is represented by the process of gendering objects (Bernotat, Eyssel, & Sachse, 2019). Even if a type of technology has no gendered cues, humans will attribute a gender to it. Therefore, robots are more likely to be perceived as male rather than female., yet virtual assistants are more likely to be perceived as female (Bernotat, Eyssel, & Sachse, 2019).

This perspective has been also analyzed in the interaction between children and robots. One experiment analyzes the possibility of inducing counter stereotyping roles in children by manipulating robots using the Wizard-of-Oz Method (Song-Nichols & Young, 2020; Vega et al., 2019) to measure whether this could diminish stereotypes in individuals. The findings emphasize that children further apply the believes about robot occupations to real-life situations, suggesting that they use robots as models which can either reinforce or suppress gender stereotypes in real life (Song-Nichols & Young, 2020). Some articles, yet few, mention no presence of gender stereotypes in technology performance in either male or female agents, especially in gender-neutral tasks such as pedagogy (Pfeifer & Lugrin, 2018). The most promising gender-neutral situations are the ones in which a robot's age is manipulated. Thus, child-like designed robots are more likely to not be perceived in the gender binary and avoid stereotypical situation when communicating with humans (Ladwig & Ferstl, 2018).

Since virtual assistants are social actors, gender stereotypes are not only affecting the perceived task competence, but the overall human-machine interaction and communication processes. This presumption is supported by Media Equation Theory which implies that the processes behind interpersonal communication apply to human-machine interaction and affect individual's social judgements (Dufour & Ehrwein Nihan, 2016).

Findings on artificial intelligence suggest that the presence of gender stereotypes is balanced (Nag & Yalçın, 2020). While some studies emphasize the presence of gender stereotypes (McDonnell & Baxter, 2019), others are presenting opposite results (Nag & Yalçın, 2020). Surprisingly, more articles present female virtual assistants as more competent than male virtual assistants. The literature suggests that this is probably because social agents are more likely to be designed as female-gendered (Borau et al., 2021; Ferreira da Costa, 2018), whereas other types of technology, such as robots, are more often designed to be male-gendered (Ferrando, 2014; Bernotat, Eyssel, & Sachse, 2019).

Several artificial assistants are anthropomorphised as females due to individual's perceptions on female traits (Ernst & Herm-Stapelberg, 2020). As humans tend to prefer

human-like machines, female features include more emotional human-like attributes such as warmth, friendliness, traits that increase their general acceptance (Borau et al., 2021). Contrary, male agents are more likely to be perceived as a threat (Otterbacher & Talias, 2017).

Many female agents are designed to have warm and submissive traits (Cercas Curry et al., 2020). Moreover, in many cases they depict different level of sexualization (Gustavsson, 2005). While the literature mentions their effectiveness on persuading men, what is worrying is that female virtual agents are the most likely to become objects of aggression and sexual abuse (Brahnam & De Angeli, 2012). While this is not affecting the technical tool itself, the violent behavior of the individuals regarding the submissive assistant is worrying (Veletsianos, Scharber & Doering, 2008). This could not only further promote gender stereotypes, but even normalize the objectification of women.

Likewise, agents' visual representation is often responsible for inducing different stereotypes that impairs the judgement regarding the effectiveness of the specific technology (Bernotat, Eyssel & Sachse, 2019). Since women are associated with more humanlike traits, many companies intentionally feminize technological assistants to increase their acceptance (Borau et al., 2021; Furqon et al., 2021). Yet, sometimes designing female agents help inducing stereotypical traits. While male agents are usually designed to look normal, female ones are exhibiting different attractive actions such as waving, winking, smiling to their users (Gustavsson, 2005). Increased visual attractiveness and sexual elements in agents' design may help in creating higher acceptance towards male-gendered agents (Guo et al., 2020), yet the result led to stereotyping and abuse (Veletsianos, Scharber & Doering, 2008).

Often in gender-neutral tasks, a lower level of stereotyping for both male or female virtual assistants is noticed (McDonnell & Baxter, 2019). Other factors such as the age of the virtual assistant may affect perception on its capability (Pak, McLaughlin, & Bass, 2014). In this way, older female agents are treated more harshly and are more stereotyped by the users than younger female assistants (Pak, McLaughlin, & Bass, 2014).

METHODOLOGY

To have a better understanding on how gender stereotypes are attached to technology, a systematic literature review is developed. With the aim of gaining a general view of the topic, a significant number of studies were selected from the current literature. In this respect, PRISMA (Preferred Items for Systematic Reviews and Meta-Analysis) method was applied as a provision for choosing the most appropriate papers (Bereczki & Kárpáti, 2018). The method consists of the following steps: (1) analysis of the potential keywords; (2) multiple data-base database searches using the keywords; (3) papers' selection after content analysis; (4) information that follows the criteria set extraction; (5) analysis and evaluation of the findings. Figure 1 summarizes the selection process.

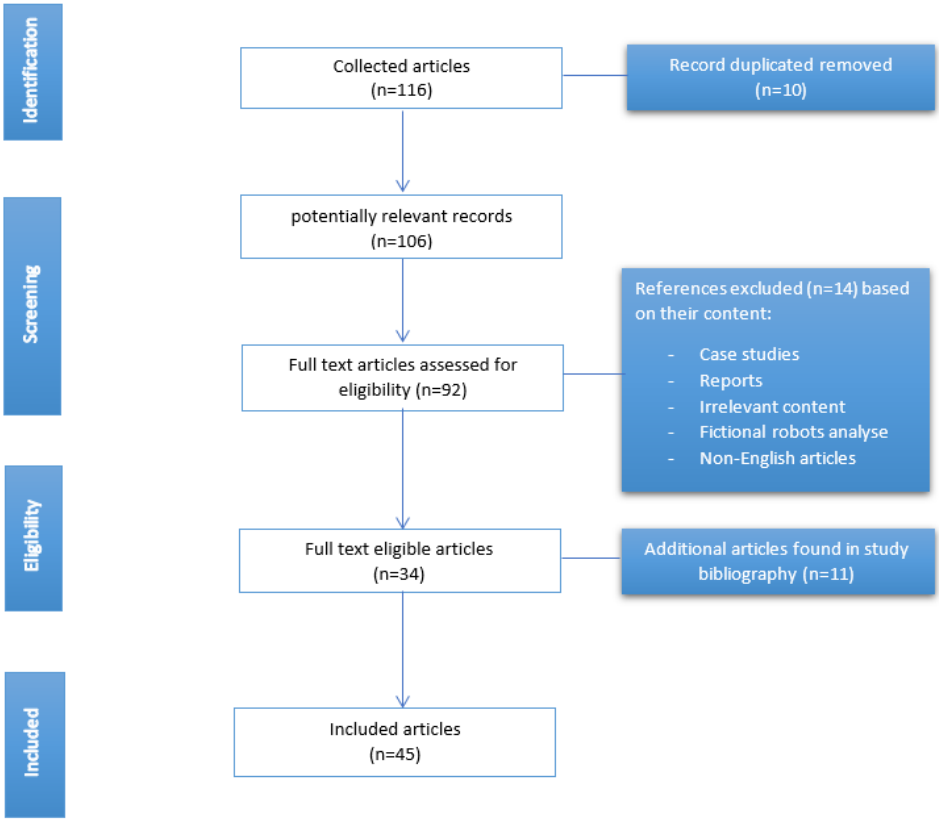

Figure 1. PRISMA flow chart for articles selection

Selection Criteria

The following items have been taken into consideration in the selection process: (1) topic - studies that follow the presence and the effects of gender stereotypes on technology (virtual assistants, robots, machines etc.); (2) aim of the study; (3) language (English); (4) full text access to the article.

Regarding the exclusion criteria, articles on the following topics have been omitted from the analysis: gender stereotypes that apply to individuals that interact with technology, gender studies that apply on technology which are not focused on stereotyping, articles that are oriented towards gender design of robots/virtual assistants and not on the presence of gender stereotypes, or articles that focus on other type of technology stereotyping (age, race) and that are excluding gender.

Search Strategy

Since the topic is relatively recent and few research approaches are present in literature, the studies have been selected without a time criterion. Thus, in order to have a longitudinal overview, the articles have been searched using relevant keywords in major databases, such as Oxford Academic, MDPI, ProQuest, ERIH Plus, Science Direct, ACM Digital Library, NCBI, ACL Anthology, or Research Gate. The used keywords are the following: gender stereotypes

and technology, gender stereotypes and artificial intelligence, gender stereotypes and robots. Moreover, similar articles suggested by the journal websites have been considered during the research, as well as the relevant studies found in the bibliographies of the selected articles. Both scientific articles published in journals and proceedings' papers have been used.

After evaluating the selected databases, a number of *N*=45 studies that respect the imposed criteria have been extracted and analyzed. Several studies have been excluded due to lack of access or incomplete published parts. Table 1 presents all the publications included in the analysis.

Table 1. The sample of articles included in the analysis

No.	Journal / Proceedings	Number of articles	Source
1	Cyberpsychology, Behavior, and Social Networking	1	Kim et al., 2019
2	Interacting with Computers	3	Brahnam & De Angeli, 2012; McDonnell & Baxter, 2019; Veletsianos, Scharber, & Doering, 2008
3	Journal of Science and Technology of the Arts	1	Ferreira da Costa, 2018
4	Gender, Work and Organization	1	Gustavsson, 2005
5	European Journal of Futures Research	1	Ferrando, 2014
6	International Journal of Social Robotics	5	Law, Chita-Tegmark, & Scheutz, 2020; Kuchenbrandt et al., 2014; Bernotat, Eyssel, & Sachse, 2019; Weßel, Ellerich-Groppe & Schweda, 2021; Carpenter et al., 2009
7	Educational Technology & Society	1	Haake & Gulz, 2008
8	Computers in Human Behavior	2	Tay, Jung, & Park, 2014; Chang, Lu, & Yang, 2018
9	Journal of Applied Social Psychology	2	Eyssel & Hegel, 2012; Nass, Moon, & Green, 1997
10	Journal of Business Research	1	Ahn, Kim, & Sung, 2022
11	Social Sciences	1	Dufour & Nihan, 2016
12	Psychology & Marketing	1	Borau et al., 2021
13	Ergonomics	1	Pak, McLaughlin, & Bass, 2014
14	Frontiers in Robotics and AI	1	Ghazali et al., 2018
15	Cognitive Development	1	Okanda & Taniguchi, 2021
16	International Journal of Human-Computer Studies	1	Lee, 200
17	Proceedings of the Second Workshop on Gender Bias in Natural Language Processing	1	Cercas Curry, Robertson, & Rieser, 2020
18	Proceedings of the 20th ACM International Conference on Intelligent Virtual Agents	1	Nag & Yalçın, 2020
19	IOP Conference Series. Materials Science and Engineering; Bristol	1	Furqon et al., 2021
20	International Conference on Information Systems (ICIS) 2020	1	Guo, Yin, Liu, Xu, 2020
21	14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)	1	Chita-Tegmark, Lohani, & Scheutz, 2019
22	Proceedings of Gender and IT Appropriation. Science and Practice on Dialogue - Forum for Interdisciplinary Exchange	1	Want & Young, 2014
23	CogSci 2020 Conference, Toronto	1	Song-Nichols & Yong, 2020

24	International Conference on Artificial Intelligence in Education	1	Pfeifer & Lugrin, 2018
25	Proceedings of the 10th international conference on Engineering Psychology and Cognitive Ergonomics: understanding human cognition	1	Tay et al., 2013
26	Ergonomics	1	Pak, McLaughlin, & Bass, 2014
27	13th International Conference on Ubiquitous Computing and Ambient Intelligence UCAmI 2019	1	Vega, Ramírez-Benavides, Guerrero, and López, 2019
28	Proceedings of the Human Factors and Ergonomics Society Annual Meeting	1	Watkins & Pak, 2020
29	Proceedings of the Annual Hawaii International Conference on System Sciences	1	Ernst & Herm-Stapelberg, 2020
30	TRAITS Workshop Proceedings (arXiv:2103.12679) held in conjunction with Companion of the 2021 ACM/IEEE International Conference on Human-Robot Interaction, March 2021	1	Neuteboom & de Graaf, 2021
31	Proceedings of the 4th Conference on Gender & IT - GenderIT '18	1	Ladwig & Ferstl, 2018
32	Proceedings of the 18th International Conference on Intelligent Virtual Agents	1	Thellman et al., 2018
33	International Conference on Information Systems (ICIS) 2019 Conference	1	Pfeuffer & Toutaoui, 2019
34	RO-MAN 2021 Workshop on Gendering Robots: Ongoing (Re)configurations of Gender in Robotics (GenR)At: Virtual conference	1	Perugia, 2021
35	International Conference on Culture and Computing, 2015	1	Nomura & Kinoshita, 2015
36	Proceedings of the 2017 ACM/IEEE International Conference on Human-Robot Interaction	2	Otterbacher & Talias, 2017; Reich-Stiebert & Eyssel, 2017

DATA ANALYSIS

For the data analysis, a set of items from each publication has been considered: publishing data, author, title, journal, volume and number, topic, research questions, aim of the study, key concepts, conceptual framework and the relevant literature, method, hypothesis, measurements, sample, independent variables, dependent variables, results, hypotheses (validated/invalidated), discussion/limitations, and research perspectives.

Most of the selected articles are published in international journals (60%, n=27), while the rest (40%, n=18) are published in conference proceedings. The thematic is multidisciplinary. The analyzed articles are part of several fields such as: social sciences, technology, pedagogy, arts, marketing, business, ergonomics, linguistics and organization. The methodological designs are either quantitative, qualitative, or mixt. There is a prevalence for quantitative data analysis. More than half of the articles (68,88%, n=28) approach an experimental perspective.

The majority of the articles are based on Computers as Social Actors Theory (CASA) and explain the individual's inclination to apply gender stereotypes on different technologies through the anthropomorphizing process. Several articles describe the stereotypes as concept,

as well as gender stereotypes and offer different definitions for these psychological processes. Gender stereotypes have been associated with the age and sex of the individual as well as with personality traits (Chang, Lu, & Yang, 2018) or race (Brahnam & De Angeli, 2012). Likewise, the main independent variables that can induce gender stereotypes in human-computer interaction are: attitudes towards the assistant or agent (Borau et al., 2021; Wang & Young, 2014; Ghazali et al., 2018) the type of task performed by the agent (Dufour & Ehrwein Nihan, 2016), emotional intelligence (Law, Chita-Tegmark, & Scheutz, 2020; Chita-Tegmark, Lohani, & Scheutz, 2019), perceived competence (Kuchenbrandt et al., 2014; Eyssel & Hegel, 2012; Vega, et al., 2019; Reich-Stiebert & Eyssel, 2017), and perceived warmth (Kim et al., 2019; Nass, Moon, & Green, 1997; Bisconti & Perugia, 2021; Ahn, Kim, & Sung, 2022). Thus, while female-gendered technology is mainly associated with warmth (Neuteboom & de Graaf, 2021), communal traits (Eyssel & Hegel, 2012), and affective trust (Bernotat, Eyssel, & Sachse, 2019), male-gendered technology is associated with competence (Pfeuffer et al., 2019), agentic traits (Eyssel & Hegel, 2012), and cognitive trust (Bernotat, Eyssel & Sachse, 2019).

The effects of gender stereotypes on technology are mainly associated with different performing attributes (Vega et al., 2019). If the level of perceived competence is low, the individuals are less likely to interact with and accept a certain type of technology or to perpetuate the stereotypes in real life interactions (Kuchenbrandt et al., 2014).

RESULTS

The results of the systematic literature review are presented in a dichotomous manner. First, the gender stereotypes are discussed in studies regarding virtual assistants. Second, the same topic is approached in the context of robots.

Gender Stereotypes on Virtual Assistants

Stereotypes are cognitive processes that help individuals identify problematic issues regarding a person. This is the reason why it is difficult to reshape them to avoid their negative effect. However, technology can help shape new generations that could become less oriented towards strong stereotypes that lead to discrimination (Haake & Gulz, 2008). Gender stereotypes are highly frequent while communicating with conversational agents or virtual assistants. It is suggested that this issue affects the human-machine relation more than the effectiveness of transmitting a certain information (Cercas Curry et al., 2020).

Artificial intelligence agents are perceived differently depending on variables and situational contexts (e.g., competences, age, design). The present studies are divided into two groups regarding perceived competence. However, there is a very low difference between the perceptions regarding male assistants and the ones that refer to female assistants. While more than half of the studies (55,56%) suggest that male assistants are perceived as performing better than female, the rest of the publications (44,44%) present better perceived opinions for female assistants. Gender stereotypes are more often applied on technology where the gender is not actually matching a stereotypical occupation. Thus, technology that embodies women who perform a male-specific task causes more stereotypical perceptions in an individual's minds than one that performs a female-specific role (McDonnell & Baxter, 2019).

Some studies are presenting surprising results on virtual assistants' competences. In some instances, female-gendered technology is more efficient than male-gendered one, which suggests they possess likeable attributes for individuals interacting with them. In the current situation male are being more likely to be persuaded by a female virtual agent, while oppositely, the male agents are having a negative impact on real women (Guo et al., 2020).

Another study suggests that female-gendered technology, specifically conversational agents, are more likely to be perceived as competent than men in male-specific domains. The identified results assumed that female agents are perceived as being competent in cooperative tasks, independently of the area of activity. Thus, even if the domain in which they perform is specific for men, their competence will be perceived as higher if the action implies cooperation (Pfeuffer, 2019).

Virtual assistants are also evaluated in relation with age. This variable generates worse ratings for the femalegendered virtual assistants in older adults (Pak, McLaughlin, & Bass, 2014). In one of the analyzed studies, this difference is observed through individual's attitudes towards virtual assistant recommendations. While the level of trust on utilitarian products recommendations was higher for male assistants, for the female assistants the hedonic products raised a greater amount of trust (Ahn, Kim, & Sung, 2022).

Another problematic approach refers to the level of which the stereotypes are reinforced in virtual assistants by design. It is an issue that many artificial intelligence tools embody females and manifest stereotypical behaviors while they are programmed by men (Gustavsson, 2005). Virtual assistants are often built to denote feminine traits such as caregiving or showing interest despite their task (Ferreira da Costa, 2018). Human attributes are associated with emotions and warmth. The literature suggests that this is a possible cause of consumer preference for female artificial intelligence assistants (Borau, Otterbring, Laporte, & Fosso Wamba, 2021).

Research similarly indicates that female-gendered systems are perceived as more trustworthy when the reliability is low, compared to men. This implies that a male-gendered voice assistant is seen trustworthy only when its functionality is high (Watkins & Pak, 2020). In this way, the presence of gender stereotypes is confirmed since women are more likely to be perceived as trustworthy due to the difference in social power.

Diminishing stereotypes on technology is crucial as individuals tend to exhibit abusive behavior on technology and further manifest aggressive behavior on virtual beings. This situation can potentially worsen their perceptions regarding one of the genders in the real life (Veletsianos, Scharber, & Doering, 2008).

Gender Stereotypes on Robots

Many studies mention that individuals apply the categorization process to inanimate objects and in relation with technology. Individuals have difficulty interacting with genderless entities. If the gender of a machine is not pre-defined, humans will attribute one for it subconsciously. Therefore, it is still not likely to erase stereotypes by designing genderless robots yet (Ladwig & Ferstl, 2018). While they are rarely considered to be a female in the absence of specific cues, robots or cyborgs are usually associated with male gender or with being gender neutral (Ferrando, 2014). The differences in a robot's gender perception may vary in respect to competence, social roles attributed to humans in different contexts, and emotional traits.

Studies on technology and education claim that children start to have strong stereotypes at the age of 5. Yet, they are highly prone to have flexible perceptions regarding stereotypes during and before that age. Thus, children are more likely to have stereotypical opinions when exposed to traditional gender roles and non-stereotypical when stimulated to have counter-specific believes (Song-Nichols & Young, 2020). Children older than 5 years old attribute different objects with a specific gender. In this way, they consider that a car is a male and a flower is a woman. Moreover, young boys are more likely to see objects as being male-gendered.Children younger than 5 have a more flexible assignment of gender to objects , which suggests than gender stereotypes could be diminished in working with young children (Okanda & Taniguchi, 2021).

Most of the studies that focuse on analyzing perceived competence on robots present no relation between competence and robot's gender (Nag and Yalçın, 2020; Pfeifer & Lugrin, 2018). Interestingly, the relation between gender and competence suggest that female robots are more frequently perceived, in the current studies, as being more competent than male robots (Vega et al., 2019; Guo et al., 2020). The level of pleasure while interacting with technology is presumed to be related to matching gender-stereotypical traits. Robots are identified with male traits through the process of categorization and they could be stereotypically judged from this gender when performing a task (Bernotat, Eyssel, & Sachse, 2019). Technology designed with counter-stereotypical approaches and occupations specific for the opposite gender decreases the affective evaluations of the individuals communicating with them (Tay, Jung, & Park, 2014). Individuals have higher trust on gender-matching roles. One study suggests that when a computer is generating answers matching their imposed gender, individuals are more likely to change their initial answers on the topic and trust the robot's recommendation (Lee, 2003).

Visual representation is one of the most relevant factors in generating stereotypes regarding the gender role of computers (Lee, 2003). Certain physical traits determine individuals to attribute a gender to technology. One of the analyzed articles suggests that participants are more likely to choose a task related to mathematics to male robots, while they have no specific preference for the female task (Eyssel & Heagel, 2012). Overall, the literature suggests that performing the task successfully is the key to decrease stereotypical believes on robot gender (Neuteboom & de Graaf, 2021).

In some studies, female robots are suggested to be more persuasive than males (Ghazali et. al, 2018). Female robots are rated higher in performance and preferred during interactions due to individual's perceptions of women as responsible and reasonable beings. However, there was no significant difference between the two genders (Vega et. al., 2019). Other studies present results in which female-gendered robots outperform male ones, both in sympathy perception and in intelligence (Vega et al., 2019). Additionally, women traits are perceived as more likeable and thus they have a higher degree of acceptance (Chang, Lu, & Yang, 2018). While technology that embody a female is preferred in general by both human genders, robots of opposite gender are rated as more credible and trustworthy. These results are probably related to real life perceptions regarding the opposite gender (Nomura & Kinoshita, 2015).

Individuals believe that certain gender stereotypes are genuine. Thus, they have strong assumptions when they receive evaluations from a computer. Evaluations from men are considered more valid than those coming from women. Similarly, the level of dominance is more acceptable in male-gendered computers than in female ones. These assumptions are

outlined by individuals even if they are aware that a computer is just a tool, yet their perception is biased and they are transferring real-life attitudes on technology (Nass, Moon, & Green, 1997).

Gender stereotypes are activated on situational circumstances. A robot that provides help with home chores is more likely to be associated with a woman, while security tasks are associated with man (Tay et al., 2013). Social robots are expected to act in a feminine manner and be affectionate, loyal and sensitive (Chang, Lu, & Yang, 2018). Female-gendered technology is preferred in home-use (Carpenter et al., 2009), which is further emphasizing that gender roles are still prevalent in individuals' minds. The gender of a robot is usually not affecting neutral occupations such as teaching, since it is not activating strong stereotypes (Pfeifer & Lugrin, 2018).

Emotional intelligence is a very strong factor for working with robots and technology. Previous research confirms its importance as it affects the level of perceived trustworthiness, performance and social abilities. Moreover, this variable affects gender stereotypes as people transfer their expectations in the robot and relate it to its gender. This creates a cognitive bias in working with different artificial agents (Law, Chita-Tegmark, & Scheutz, 2020). Oppositely, in some studies, robot gender is thought to be independent from emotional intelligence and trust (Law, Chita-Tegmark, & Scheutz, 2020). Gender cues are inducing different stereotypes related to emotional intelligence. In this way, female-gendered robots are perceived as having more emotional intelligence then a male robot, even if the gender manipulation is not actually influencing this attribute (Chita-Tegmark, Lohani, & Scheutz, 2019).

The reason for designing a specific gender for technology should be in relation with its effect and usage. Therefore, it is relevant to know how different situational contexts and variables influence the perceptions on gender stereotypical tasks and what are the most effective methods in which individuals can benefit from gendered technology design (Powers et al., 2005). Other studies also mention the difficulty of implementing gender-neutral robots in human-machine interaction. Thus, other measures should be considered to solve gender stereotypes issues (Bisconti & Perugia, 2021). It is suggested that one way to diminish perceived stereotypes during human-machine interaction is to provide a clear description of the characterizing of that robot. When individuals know exactly what type of tasks a robot should perform, they are less likely to make judgements based on their gender role (Dufour & Ehrwein Nihan, 2016).

DISCUSSIONS AND CONCLUSION

Gender stereotypes are still prevailing in society nowadays. Moreover, as technology and AI in particular are increasingly present in nowadays lives, a closer look on how stereotypes are transferred from human-to-human to human-to-machine interaction becomes of paramount interest. Being a rather debatable, incomplete and scarcely understood perspective, the relation between gender and technology calls for a comprehensive overview. The present paper has developed a systematic literature review on studies approaching gender stereotypes attached to both virtual assistants and robots.

The first research question (RQ1) aims to better understand how technology is being labeled from a gender perspective. The results outline that most of the chatbots and artificial

intelligence assistants are designed to be female (Cercas Curry, Robertson, & Rieser, 2020). Since females are perceived as warmer and less dominant, their level of likeability increases in the user's mind (Borau et al., 2021). Interestingly, this idea does not apply on robots as well. Robots rather emphasize a masculine embodiment; even when they have female gender cues, they are somehow physically robust (Bernotat, Eyssel, & Sachse, 2019). Moreover, the literature highlights that robots are males according to the categorization process. Thus, to avoid a cognitive dissonance generated by female-gendered robots, the male ones are preferred in this context (Bernotat, Eyssel, & Sachse, 2019). The argument is sustained by other studies' results that outline a preference of individuals for male-gendered robots (Ladwig & Ferstl, 2018). However, these effects are situational and rather general. The labelling could be influenced by other variables, as the setting, or the situational context. Thus, while in general, a robot is generally preferred as male, when a robot works in a home environment a female is preferred (Ladwig & Ferstl, 2018).

The second research question (RQ2) draws on the way gender stereotypes are affecting the perceptions of virtual assistants and robots' competences. The present analysis confirms that stereotypes are occurring in interaction with various types of technology differently, according to the variables they are in relation with. In some instances, female-gendered technology is perceived as being more competent, while, in others, male-gendered technology performs better. It is remarqued that this could be especially due some natural gender attributes such as the female ability to be warm or empathic (Borau et al., 2021) or to male capacity to have physical power (Dufour & Ehrwein Nihan, 2016) in order to perform a certain task. While male agents are often perceived as being more competent in task solving, female agents are accepted more rapidly by individuals and the interaction is more qualitative due to humanlike perceived characteristics. In some specific instances, such as cooperative tasks (Pfeuffer & Hinz, 2019) or in persuasive contexts when the level of warmth and the lack of aggressiveness matters, female agents are perceived to perform better than male agents (Guo et al., 2020). Thus, the level of perceived competence depends on the way the task matches the gender of the agent. (Tay et al., 2013; Vega et al., 2019).

The third research question (RQ3) aims to analyze the main variables that are responsible for perceived gender stereotypes in technology. One of the most important variables is the setting, or the situational context. As most of the jobs are not considered gender neutral (Bryant, Borenstein, & Howard, 2020), analyzing the perspective from a single specific task (mechanics) is not sufficient as they are generating stereotypical responses that would be absent in gender neutral activities (banking) (Guo et al., 2020). Therefore, it would be relevant to analyze multiple tasks for obtaining accurate results. Another notable variable is the age of the user. Young and elderly individuals have different preferences for robot's gender when interacting with them (Watkins & Pak, 2020; Ladwig & Ferstl, 2018). Specifically, older individuals have stronger stereotyping believes towards female agents, compared to younger individuals (Pak, McLaughlin & Bass 2014; Ladwig & Ferstl, 2018). At the same time, a powerful effect is generated by the visual representation. While male design is rather neutral, female could be designed to look in a sexual manner and have feminized behaviors, such as smiling or winking (Gustavsson, 2005). Furthermore, the voice of an agent is a variable that has a strong influence on inducing different comfort levels for the individual. While it might be effective to design submissive voice agents to be associated with female traits and therefore

perceived as more human-like, this is another trigger for stereotyping technology. (Furqon et al., 2021).

The final research question (RQ4) emphasizes possible solutions for reducing gender stereotypes attached to technology. Current literature mentions the inability to implement gender-neutral technology at the moment (Ladwig & Ferstl, 2018). However, as stereotypes are often task related (Kuchenbrandt et al. 2014), some insights regarding potential solutions imply some elaboration of the technical prescript for the machine, in order to clarify, as much as possible, what the robot is able to do. This allows the individual to have a precise view of agent's attributes, before any stereotypes could arise regarding its performance. Likewise, positive consequences have been identified in forming believes on young children (Song-Nichols & Young, 2020; Okanda & Taniguchi, 2021). Through educational tools, children, in their path of becoming adults, can learn gender-neutral behaviors when interacting with both another person and with technology (Song-Nichols & Young, 2020). While the literature mentions the problematic aspects of gender stereotyping, it is a positive aspect that possible solutions are also offered for using technology as a tool to decrease gender stereotypes in real life situations. This could represent a very gratifying option and might provide a less discriminatory environment for future generations.

LIMITS, RESEARCH IMPLICATIONS, AND PERSPECTIVES

The limits of the study refer to three main aspects. First, the number of analyzed scientific papers included in the analysis is rather small. Although the relevant publications on the topic have been included, the emphasis mostly on virtual assistants and robots might lead to a limited perspective of the topic. Despite a thoughtful selection of the articles included in the systematic literature review, some research might not be identified. Likewise, by using exclusive English resources, important information written in different languages might have been missed. Future studies can increase the overview by incorporating gender-based studies on more technologies. Second, as the literature presents diverse results on the topic, due to situational factors and variables used, providing valid generalized perspectives is limited. Potential patterns for explaining and predicting gender-specific perceptions or behaviors within human-to-machine interaction can be developed by further studying the phenomenon in a more empirical manner. Finally, since the results are narratively synthesized, the interpretation of the literature might be subjective in patches. Thus, external experts should be involved for future systematic reviews to gain a more accurate perspective on the topic.

The implications of the present literature review are twofold. On one hand, the study manages to offer what is already known on the gender-based technology perspectives, emphasizing the main theories used in explaining stereotypical behavior and the variables that can induce stereotypes. Thus, it can provide a strong theoretical basis for future empirical approaches. The present paper identifies the implications of several variables that affect perceptions and competence of gendered technology, as typicality of the task, contextual situation, voice personality, agent personality traits (level of warmth vs dominance; agentic vs. communal traits), perceived trustworthiness, and cultural social roles. Thus, future research can explore these variables in-depth using an experimental approach. For instance, as most of the studies use a single stereotyping role to compare the effects on genders, the literature argues

for a more holistic approach by comparing multiple gender tasks in one study. Moreover, based on the solutions provided for reducing the gender stereotypes attached to technology, future studies might focus on analyzing the implementation process of these recommendations and confirm their validity.

On the other hand, the gained information can be used in different domains, at the business and industry levels. For instance, while in the organizational communication domain virtual agents are working alongside with human employees, gender stereotypes can be corrected by acknowledging their existence and implications. As technology is more present in pedagogy, the educational field can benefit from teaching children a politically correct approach to treat virtual assistance and robots and, consequently apply the neutral-gender labeling in human-to-human interaction. Having increased assistive technology and virtual caregivers, the medical field can better understand human-to-machine communication of both young and elderly users. Nevertheless, the information gained at the research level can be useful for technology and applications' designers. Considering that gender stereotypes used in human-to-machine interaction can degenerate and further used within the human-to-human communication, a machine gender-neutral perspective can have a vital educational role.

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